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CONTENTS

Number 1. March, 1937

Number 2. June, 1937

CONTENTS

Number 3. September, 1937

Number 4. December, 1937

DEVELOPMENT WITHIN THE FIRST TWO YEARS OF INFANTS PREMATURELY BORN[1]

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The majority of studies of infants prematurely born have been concerned with physical rather than mental development. Recently, however, Ypplo (12) has reported 7.4 per cent of more or less gross mental defect among his numerous patients. He also quotes Sarvan who found 8.7 per cent of cases mentally defective among 3174, and Brander who examined 376 prematurely born children of school age by means of the Terman Revision of the Binet-Simon Scale and found 11.2 per cent had an intelligence quotient equal to or less than 70. In this study the parents also were examined and only two cases of mental deficiency were found. Finally, Montserrat (9) working in the Psychological Institute in Vienna examined infants between 24 days and 10 months of age with the Bühler-Hetzer tests (2). He stated that the "normal" range of intelligence quotients for these infants was from 65 to 95, instead of from 90 to 110, as for children born at term.

All of these studies have failed to distinguish between the fact of prematurity per se, and other pathological conditions which do frequently accompany premature birth but are not peculiar to it. Especially the cases of cerebral hemorrhage have not been treated separately. In the recent careful study by Mohr and Bartelme (8) where this distinction was made, an almost normal distribution was found. Looft (6) in his study of rachitic prematurely born children came to the conclusion that the mental retardation which he found was due mainly to the rachitis. Very few of the children in these studies were within the first two years of life, however. Comberg (see 8) also stated that he found in the prematurely born delayed development, but not lasting retardation. Especially in walking and talking, up to 12 months of age these children lagged behind the average. The maximal retardation was in children whose birth weight was less than 1600 gms. At a birth weight over 1600 gms. there was an average delay of 4 months, while at 2000 gms. birth weight, the children reached normal performance.

Gesell (4) presented only one case in evidence for his contention that birth is merely an incident in the maturation pattern, and the age of the prematurely born child must be corrected for the amount of prematurity in reckoning the developmental quotient. He admitted, however, that the discrepancy between age reckoned from birth date and age reckoned from conception might become negligible by school age, and also that in infancy the premature might profit from early exposure to sensory and social stimuli.

PROBLEM

The purpose of the present study was to discover whether differences, either quantitative or qualitative, between prematurely born and full term children within the first two years of life might be shown with especial clarity by means of

[1] A study from the Psychological Institute at Vienna. The author is under obligation to Frau Professor Charlotte Bühler and Frau Dr. Liselotte Frankl for direction in this study, and to the Institute staff for many courtesies.

the Bühler-Hetzer infant tests. Quantitatively the questions were: (1) how do the prematurely born compare with full term children in general intelligence month by month; (2) are there differences in rate of mental growth from month to month among the prematurely born within this early period, and if so at what age is their rate of development most rapid; (3) if they are retarded in comparison with full term children, at what age, if at all, do they catch up? Qualitatively it would be desirable to know: (1) if they are retarded in particular developmental dimensions in relation to others; (2) if there is any general tendency in the pattern of development, and (3) if there are character traits which seem peculiar to these children.

SUBJECTS

The tests were applied to a group of 44 prematurely born infants ranging in age from 1 month and 15 days to 18 months and 25 days. All but two of these children had been cared for after birth in the premature ward of the Reichsanstalt für Mutter-und-Säuglingsfürsorge in Vienna. Access to them was made possible by the cooperation of Dr. Arnulf Maier of the hospital staff. The two exceptions were seen in the ward of the Karoliner Krankenhaus.

Of these 44 children, 3, (6.8 per cent) showed physical symptoms which suggested cerebral hemorrhage. This corresponds remarkably well with the percentage of mental deficiency found in the Scandinavian studies. Two of the three were definitely injured and are not included in this study. In the remaining case the suggestion was slight and indefinite, and the baby was included in the group, with a note as to the doubt.

Ten of the 42, or 24 per cent were examined in the hospital ward. Of these, 5 were within the first three months of life and had not yet been dismissed to their homes; 5 had returned to the hospital after previous dismissal, 4 because of nutritional difficulty and 1 because of illness of the mother. It is important for the results of this study to note that only 5 children in the group had not had the experience of care in their own homes, and these 5 were still very young. Thirteen or 30 per cent were examined in the doctor's office, where they were brought by their parents for a routine follow-up examination, and 19 or 46 per cent were examined in their own homes. No child examined at home or in the ward refused cooperation. Under the unaccustomed conditions of the doctor's office, some cooperated well and apparently were not upset. Others showed fatigue and nervousness resulting from the break in their usual schedule and the trip from home, and possibly did not perform to the best of their ability. When the upset was marked, however, the examiner followed up the child later at home.

In addition to the tests, observation and protocol of the child's activities during a free play period, and conversation with the parents, information concerning each infant was sought from the hospital records. In most instances these contained a description of the birth and neonatal period and a few items of social data. Since the babies were all born either at some other hospital or at home and transferred to the Reichsanstalt for special care at periods ranging from a few hours to several weeks the birth data were not always complete. For our purposes, however, the chief interest in the hospital records is to show that

these infants were a reasonably representative sample of healthy though prematurely born children. To this end, the information from the blanks has been summarized in the following statements:[1]

1. There were 3 sets of twins in the group, and 3 other survivors of a twin birth. Two of the latter were the first-born of the pair, and one was the second-born. Only 5 of the families included one other child; one had 2 others, and in 30 the premature infant was the first birth. Six records were lacking. In 3 cases, one previous abortion had occurred; in one case, 2, and in one case 7 spontaneous abortions preceded the birth of the viable infant. In this case the child was brought near term only by special glandular feeding of the mother.

2. The parents, with a few exceptions, were of the skilled laborer or small tradesman class of Vienna. The exceptions included two dentists and one teacher. In 14 cases the home consisted of one room and kitchen; in 17 cases there was a kabinette in addition, and one home visited was a 5-room apartment. In 22 instances it was recorded that only the parents lived in the home; in 6 cases there were 3 adults and in 5 other cases more than 3 adults. The rest were not recorded.

3. Eleven of the babies came to the Reichanstalt on the day of birth; 3 on the day following birth, and 23 at periods ranging from 4 days to 11 weeks.

4. In 12 cases the duration of labor was not recorded. In 5 cases it was more than 14 hours; in 13 cases less than 6 hours, and in 13 cases within these limits. The average length of labor for prima paras is usually considered between 12 and 14 hours, but 11 of the 13 shorter-than-6-hour labors occurred in prima para cases.

5. Asphyxia of the infant at birth was noted only 4 times in the records. No statement was made in 10 instances. In 27 cases the birth was spontaneous, in 5 forceps were used, and in 8 there was no statement.

6. In 17 cases there was mention of overriding of the skull bones or other considerable molding of the head in the birth process. In 18 cases the head was described as well formed and no mention of molding was made. In 5 cases there were no data. Softening of the skull bones (cranio tabes) in the neonatal period was noted in 16 cases. In 15 cases the bones were described as hard and no mention of softening occurred. In 9 cases there was no statement.

7. Icterus in the neonatal period was noted in 14 cases, cyanosis, or blueness around the mouth and nose, in 12 cases.

8. Nutritional difficulty involving loss of weight after the normal initial period of weight loss occurred in 8 cases. This was in every case overcome and the baby gaining well before discharge from the hospital.

9. The following conditions were noted in the group: previously syphilitic

[1] In 4 cases no history of the case could be obtained.

mother, though with negative WAR at the time of the child's birth - 2 cases; spina bifida - 1 case; heart murmur - 1 case; gastric tumor - 1 case; rattle over lung in breathing - 2 cases; attack of tetany - 1 case; possible hydrocephalus - 1 case; somewhat spastic extremities - 2 cases; plexus paralysis - 1 case; rickets - 1 case; marked restlessness, apparently nutritional - 2 cases; naval hernia - 3 cases. Minor ailments such as colds and slight gastric disturbances occurred in a number of cases.

Besides having a longer period of scientific feeding and observation than the average infant after birth, the children cared for at the Reichanstalt were followed up by the hospital authorities and their parents instructed as to their care. Moreover, a certain amount of selection occurred in the cases studied here in that all of the parents whose children had been dismissed showed sufficient interest in their welfare to cooperate with the hospital's follow-up program. With respect to intelligent care, therefore, the fact of prematurity probably set them above average.

TEST RESULTS

The quantitative test results are shown in Table 1. Column 1 gives the number of the case; Column 2, the life age of the child; Column 3, the developmental age obtained from the test performance; Column 4, the developmental quotient obtained by dividing the developmental age by the life age, and Column 5, the birth weight of the child where this was obtainable. At the end of the table the data from the 2 cases of cerebral hemorrhage are added. Case 2 is the doubtful case mentioned in the previous section. The three cases of nutritional difficulty mentioned in the notes are instances where the child had returned to the hospital for this cause and was examined in the ward, after a previous dismissal. The notations used throughout to express the child's age are to be read as follows: Case 1, L.A. 1 month and 15 days; D.A. 1 month and 15 days; D.Q. 100. Case 26, L.A. 1 year, 2 months and 1 day; D.A. 1 year, 1 month and 15 days; D.Q. 96.

The table shows that within the first three months there was on the average considerable retardation. Unfortunately there were no cases in the fifth month of life. From the sixth month on, the averages were over 100.

Figure 1 shows in graphic form the distribution of D.Q. scores obtained from the examinations. This is a normal distribution, in contrast to that obtained by Montserrat.

Figure 2 shows that there is a marked extension in the upper limit of the distribution of each successive age group up to the 11-14 months period. The figure also shows that there was not much difference in the lower limit of the distribution after the first three months.

Up to this point no account has been taken of the birth weight of the infant nor the length of the period of gestation. For the 39 cases in which birth weight was obtained, the correlation between birth weight and D.Q. was 41 ± .08. (Pearson product-moment method.) Moreover, the average D.Q. of the 22 children having birth weights of 2000 gms. or less was 102.7, while the average for the 17

TABLE 1

Life ages, developmental ages, alopmental quotients and birth weights of 44 prematurely born infants, examined with the Bühler-Hetzer infant tests.

No.	L.A.	D.A.	D.Q.	B.W.	Notes
1.	0; 1+15	0; 1+15	100	2800 gms.	
2.	0; 1+16	0; 1+ 3	71	2600	Possible hemorrhage
3.	0; 3+ 0	0; 3+ 0	100	2160	
4.	0; 3+ 5	0; 2+24	88	1950	
5.	0; 3+12	0; 3+ 0	88	2130	
6.	0; 3+17	0; 3+ 3	90	2000	
7.	0; 3+22	0; 3+ 0	80	--	Nutrition difficulty
		Average	88.14		
8.	0; 5+20	0; 6+ 6	109	2700	
9.	0; 6+ 3	0; 6+15	106	1600	
10.	0; 6+13	0; 6+21	104	--	
11.	0; 7+ 9	0; 7+12	101	1770	
12.	0; 7+19	0; 8+ 9	112	2050	
13.	0; 8+21	0; 8+ 9	95	--	Nutrition difficulty
14.	0; 8+27	0; 9+18	108	1800	
15.	0; 8+26	0; 8+24	99	1900	
		Average	104.26		
16.	0; 9+ 8	0;11+18	127	1950	
17.	0; 9+14	0; 9+12	99	1500	
18.	0; 9+15	0; 9+15	100	1350	
19.	0; 9+25	0; 9+18	98	1400	
20.	0; 9+25	0;11+24	120	2700	
21.	0;10+ 0	1; 0+ 3	121	2050	
		Average	110.83		
22.	1; 0+ 0	0;10+24	90	1690	
23.	1; 0+ 3	0;10+18	87	1200	
24.	1; 1+ 9	1; 1+ 9	100	1800	
25.	1; 1+ 9	1; 1+ 9	100	1680	
26.	1; 2+ 1	1; 1+15	96	1900	Anaemia
27.	1; 2+ 6	1; 9+18	159	2400	
28.	1; 2+ 9	1; 3+18	109	2180	
29.	1; 2+ 9	1; 2+ 3	99	1530	
30.	1; 2+15	1; 4+ 6	112	2130	
31.	1; 2+15	1; 7+16	134	2800	
32.	1; 2+15	1; 4+15	114	2230	
33.	1; 2+16	1; 8+12	140	2250	
34.	1; 2+23	1; 8+ 3	136	1980	
		Average	113.5		
35.	1; 3+ 5	1; 9+ 0	138	1850	
36.	1; 3+22	1; 4+24	108	2500	
37.	1; 3+25	1; 3+ 3	95	1260	
38.	1; 4+ 3	1; 6+ 9	113	1900	
39.	1; 4+ 5	1; 8+ 3	124	2000	
40.	1; 4+ 7	1; 4+ 6	99	830	
41.	1; 5+24	1; 8+ 3	112	1600	
42.	1; 6+25	1; 7+24	105	2019	Nutrition difficulty
		Average	111.75		

TABLE 1 - Continued

No.	L.A.	D.A.	D.Q.	B.W.	Notes
43.	0; 6+ ?	0; 0+24	(13)		Cerebral hemorrhage
44.	0;11+ 0	0; 8+18	81		" "

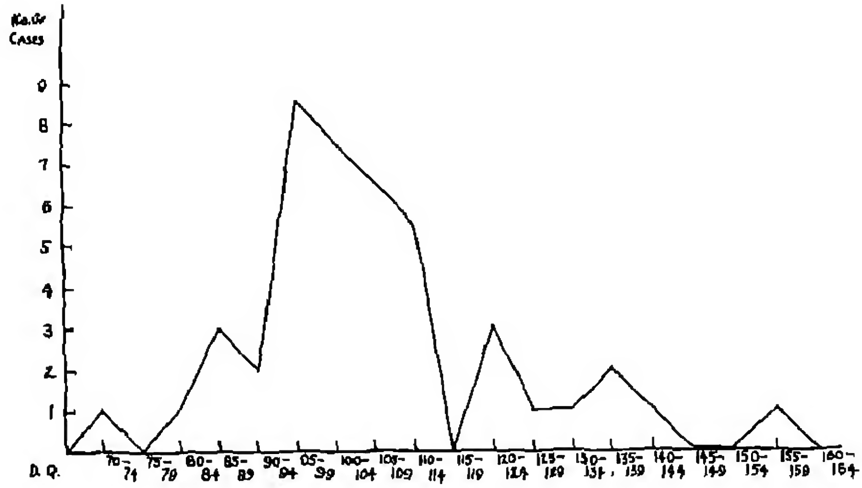


Figure 1. Distribution of developmental quotients of 42 prematurely born infants under 19 months of age examined by the Bühler-Hetzer infant tests.

children having birth weights between 2000 and 2800 gms. was 113.3. The low average D.Q. of the children between 1 and 6 months of age is not due to any bunching of the lower birth weights within this age period, however, since only one of the 6 had a birth weight less than 2000 gms.

Attempts to divide the children as to length of gestation period are always questionable because of the uncertainty. In only 29 cases in this study was the length of term stated. Of these, 10 were said to be 7-months babies, 12 were 8-months, and 7 were born in the 9th month, only a few weeks early. The means of the D.Q.'s are: 7-months, 107.9; 8-months, 105.16; 9-months, 111.7. Obviously the birth weight is a much more important factor than the probable length of gestation.

Quantitative analysis of these data, then, showed the following facts in regard to these healthy, prematurely born children:

1. The total distribution of D.Q. scores was normal, and of the same range which might be obtained among a group of children born at term.

2. The mean of the D.Q. scores of the children below 5 months of age was slightly below the range for healthy, normal, full term children. The mean of the scores of children between 5 and 9 months of age was average. From 9 to 12 months there was another rise in the mean for this group. Thereafter the fluctuations did not appear large enough to be of any significance.

3. There was a low positive correlation between the birth weight and the developmental quotient within the first two years. Furthermore, the mean of the D.Q.'s for children having birth weights of 2000 gms. or less was considerably lower than that for children whose birth weights were over 2000 gms.

4. The mean D.Q. for the children born only a few weeks early was slightly higher than that for the 7- and 8-months babies, but considering the uncertainty of this classification and the small number of cases in each group, this did not appear to be significant.

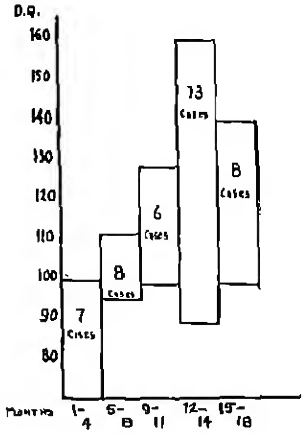


Figure 2. Distribution of developmental quotients in successive age groups of 42 prematurely born infants examined by the Bühler-Hetzer tests.

Even more interesting than the quantitative aspects of this study were the qualitative features, which were brought out with especial clarity by the use of the Vienna scale. The graphic profiles and a statistical analysis of the relative frequency with which tests were passed in the different dimensions have been used to demonstrate the peculiarities found in this group.

The number of plus and minus scores for each test was reckoned. For each child only those successes and failures within the range where both occurred were counted. Table 2 shows the result of this summary. Column 1 gives the testing dimensions found in the Bühler-Hetzer tests. Column 2 shows the number of single tests given in this dimension. There are not the same number of tests in each dimension of the scale, hence the wide differences in the number given. Column 3 shows the number of tests passed, and Column 4 the percentage passed of the total number of tests given in that dimension.

Figure 3 shows in graphic form the percentages given in Column 4 of Table 2.

The fact that sensory reception stands first may be only an indication that the responses to these tests require less motor control than do those in the other dimensions.

Closer analysis showed further specific retardations. Certain tests were failed especially often. These are shown in Table 3. Column 1 gives the test dimension; Column 2 gives the division within this dimension; Column 3, the series number designating the month of life within which the test occurred; Column 4, the

TABLE 2

Number of tests given, number and percentage passed, and number and percentage failed in each dimension.

Dimensions	Total tests given	Total tests passed	Percentage of tests passed
Sensory reception	133	101	76
Bodily movements	298	133	45
Social responses	164	103	63
Learning	218	144	66
Activity with materials	113	66	58
Mental production	101	45	45

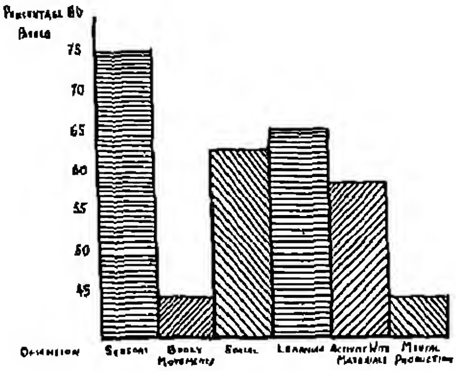


Figure 3. Percentage of tests passed in each dimension of the Bühler-Hetzer infant scale by 42 prematurely born infants.

test number within this series; Column 5, the response required for passing the test; Column 6, the total number of times this particular test was given and Column 7, the number of times that it was failed. Column 8 gives the age range of the children who failed the test. The series numbers correspond to the month of life age of the child up through Series VIII. After that more than one month is included in the test series. Series XI includes the period from 12 to 15 months of age, and Series XIII, the period from 18 to 24 months. Taking for an example Test 2 in Series XI, which requires the bodily control necessary for standing alone, the table shows that of 11 children between the 11th and 17th month of life who were given this test for the first quarter of the second year, 10 failed to pass it. All of those children had passed other tests in this series, or this

TABLE 3

Tests usually failed when occurring within the test range of the child.

Dimension	Division	Series	Test	Requirement	Times given	Times failed	Age range months
Bodily movements	Bodily control	I	9	Lifting head when prone	4	4	2nd-4th
"	"	IV	6	Lifting head and shoulders when prone	4	4	4th
"	"	IV	7	Moving arms and legs when prone	4	4	4th
"	Overcoming hindrance	VII	4	Freeing self from cloth over head when prone	6	6	5th-10th
"	"	VIII	2	Freeing self from cloth over head when sitting with support	8	6	7th-10th
"	Bodily control	XI	2	Standing alone	11	10*	11th-17th
"	"	XIII	1	Climbing onto a chair	11	11	15th-19th

*Seven of these failures were by children 14 to 16 months old.

failure would not be counted here, since it would be considered above the range of possible success for this child.

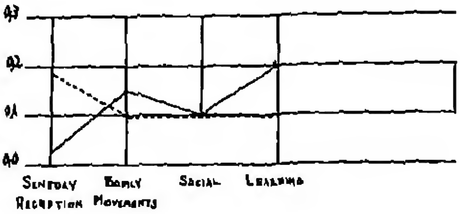
These specific tests in the dimension of bodily movements were given, altogether, 50 times, and failed 47 times, or 95 per cent of the times that they were given. Inspection shows that they all involve postural control, particularly control of the head in the early months, later in locomotion. No grasping tests appear. The developmental profiles were used to convey a graphic impression of each child's relative success in the different dimensions. In the blanks used by the Psychological Institute, the space between the horizontal lines represents the age period of the test series. On the vertical lines, the tests within this period in the dimension indicated are represented by small circles. One counts the number of tests passed by the child and places him at the corresponding level in each dimension.

The developmental profiles drawn from these cases showed only one trend persistent throughout the series. This was the upward slope from the dimension of bodily movements to that of social responses. In the 42 cases, there were only 5 instances of a downward slope, 10 of a horizontal line, and 27 of the upward slope. No other trend so consistent could be shown.

In the 4th month the tendency was for children to score at average in sensory reception, considerably below average in bodily movements, and at average or above

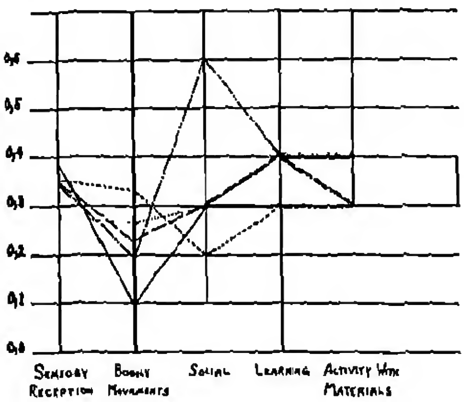
Developmental profiles of Cases 1 and 2 in the second month of life.

Case 1
Case 2



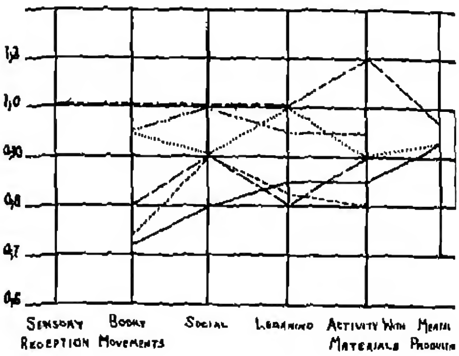
Developmental profiles of Cases 3 through 7, in the fourth month of life.

Case 3 Case 5 Case 7
Case 4 Case 6



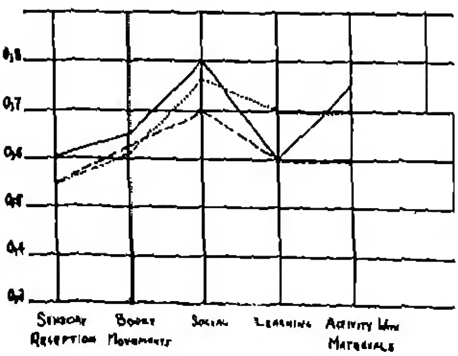
Developmental profiles of Cases 16 through 20 in the 10th month of life and Case 21 in the 11th month of life.

Case 16 Case 18 Case 20
Case 17 Case 19 Case 21



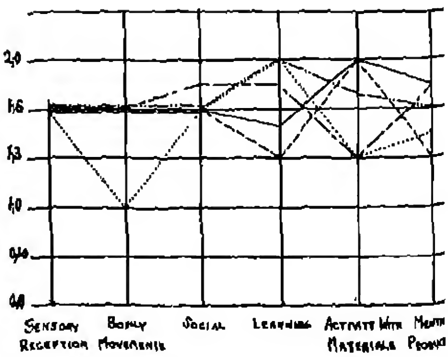
Developmental profiles of Case 8 in the sixth month of life and Cases 9 and 10 in the seventh month of life.

Case 8 Case 9 Case 10



Developmental profiles of Cases 38 through 40 in the 17th month of life, Case 41 in the 18th, and Case 42 in the 19th months of life.

Case 38 Case 40 Case 42
Case 39 Case 41



in the other dimensions. In the 6th and 7th months, the three cases plotted were below average in the dimension of sensory reception and about average in bodily movements. Why they should have fallen below the average in sensory reception at this age level is not clear. Reference to the tests shows, however, that the majority of the tests of bodily movements at this level involve grasping, and consequently allowed these children to score better than at other levels. In fact, the degree to which bodily movements were retarded varied from age group to age group. At the periods when the major forward steps in postural control should appear (sitting alone: 9th month; standing alone and walking: first half of the second year) the greatest retardation is demonstrable.

With the exception of the first two dimensions there appeared to be as wide individual differences among these children as among children born at term. In every age period the deviations above and below the average in social responses, learning, and activity with materials balanced each other, making the midpoint of each distribution fall near the midpoint of the life age distribution.

The numerical analysis showed that the percentage of tests passed in the dimension of mental production was as low as that in bodily movements. This does not show clearly in the profiles. However, in the majority of age groups the range of distribution of the scores in mental production was narrower than in the three preceding dimensions, and in two groups (Profiles 6 and 9) the whole distribution fell below the group range in life age.

QUALITATIVE NOTES

During the observation period, the examiner made notes as to the quality of the child's behavior. These notes were classified under twelve headings, which were defined as follows:

1. Passive: lack of bodily activity in response to stimuli usually calling it forth. In babies 1 to 4 months old, the stimuli were mainly change of bodily position. In older children the stimuli were mainly the test materials.

2. Active: Sustained activity, whether vigorous or quiet.

3. Positive reactions: acceptance of and approach toward materials or persons.

4. Negative reactions: continued refusal of materials and social advances.

5. Inhibited: hesitancy and tension in the acceptance of materials or social advances, usually overcome after better acquaintance with the situation.

6. Socially independent: friendly, but social stimulus not necessary for continued contented activity.

7. Socially dependent: Social stimulus preferred to materials and needed for contented activity.

8. Responsive to social advances: friendly when social stimulus is presented.

9. Makes social advances: smiles, vocalizes, offers toys, or otherwise initiates social interchange.

10. Unresponsive socially: seems unaware of other individuals.

11. Affective reactions strong: strong crying when displeased; strong activity, motor or vocal, when pleased; strong tensions in temper or fear, and the frequent occurrence of these responses.

12. Affective reactions moderate: absence of the above displays.

The distribution of the cases under these headings is given in Table 4. In a number of cases observational notes were lacking: consequently the number of cases under the categories of opposites do not total 42.

Of the 14 babies described as passive, 7 were the first 7 cases, i.e. the infants less than 4 months old. The other 7 are distributed throughout the remainder of the group.

TABLE 4

Quality of response during the examination period.

Quality	No. of cases
Passive...............................	14
Active................................	20
Positive reactions....................	25
Negative reactions....................	8
Inhibited.............................	4
Socially independent..................	12
Socially dependent....................	19
Responds to social advances...........	16
Makes social advances.................	21
Does not respond socially.............	3
Affective reactions strong............	15
Affective reactions moderate..........	25

APPEARANCE

Peculiarities in the appearance of the child at the time of the examination were noted when present. These are listed in Table 5.

In 20 cases, no peculiarity was present. The birth weights of these averaged 2147.4 gms.

In 14 cases some peculiarity in the child's appearance was recorded. The

TABLE 5

Peculiarities of appearance found among 42 prematurely born infants.

Peculiarity	No. of cases
Head slightly flat in back	3
Head very flat in back	5
Head asymmetrical: pushed right	2
pushed left	3
bump in back	3
groove in back	1
Head appears very wide above ears	5
Forehead high and prominent	3
Eyes prominent	3
Skin puffy under eyes	4
Anxious expression	2

birth weights of these cases averaged 1617.4 gms.

Nine of the 14 cases mentioned above occurred among the 21 children examined in the first year of life; 7 in the 21 cases examined in the second year of life.

SUMMARY

1. Forty-two healthy prematurely born infants were examined by means of the Bühler-Hetzer infant scale. Hospital records, protocols of spontaneous activity and observation notes furnished further information concerning each child.

2. Quantitative analysis of the tests showed that these infants lagged behind the average for children born at term up to five months of age, but scored within average limits thereafter.

3. There was a low positive correlation between birth weights and developmental quotients.

4. Qualitative analysis showed these children to be retarded, on the average, in postural control up to 18 months of age, and no children older than this were tested.

5. The personality traits predominating in the group were: positive reactions, dependence upon social stimulus and response, and rather moderate affective reactions. The moderate affective reactions may reflect a type of passivity not included in the "passive" classification as defined in this grouping. As a whole, they were gentle babies.

6. Children whose birth weights were below 2000 gms. were more likely to show some peculiarity of appearance, persistent into the second year of life, than

those whose birth weights were above 2000 gms.

CONCLUSION

The above results agree in the main with the findings of Looft, Comberg, Bartelme, and others who found that prematurely born children catch up with children born at term in a relatively short time, providing they are healthy. This is somewhat dependent upon the birth weight of the child. The Bühler-Hetzer tests demonstrated the normal general development and made possible analysis of the qualitative aspects of their performance in a definite manner. The results of this analysis are in agreement with Gesell's findings only in so far as he postulated that the prematurely born might be more advanced in sensory reception and in social responses than in some other dimensions.

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A RATING SCALE OF THE VIGOROUSNESS OF PLAY ACTIVITIES OF PRESCHOOL CHILDREN [1]

EVALINE FALES

PROBLEM

Within recent years the play of preschool children has received considerable attention from investigators. Most of the studies have been concerned with play interests of children as observed by choice of materials and length of time spent with materials in a free play situation.

The vigorousness of the play activity has sometimes been judged on the basis of the type of equipment used, but there has never been any very objective and accurate method of measuring the vigorousness of play. It was the purpose of this study to make a rating scale by which the vigorousness of preschool children's play activities could be measured and then to apply this scale in studying sex differences. The study of sex differences will be reported in a later article.

THE RATING SCALE

It was decided to construct a rating scale of the vigorousness of preschool children's play activities by using the mean opinions of expert judges. This method is frequently used in making quality scales and gives rather high consistency as measured by the correlation between the judges' ratings.

The List of Activities

A detailed list of children's activities in the preschool play situation was compiled on the basis of careful observation and diary records. When taking the diary records, the observer took care to list a new item when the apparent vigorousness of an activity changed. Thus, riding a tricycle slowly on the lawn is a different activity from riding it slowly on the pavement. In this way the scale permits great differentiation. No items relating to routine activities such as removing wraps, having orange juice, etc. were included in the list.

The final list of play activities contained 651 items. It was mimeographed and cut apart so that each item was on a separate slip of paper, to facilitate sorting and arranging according to vigorousness. A set of items was sent to each judge with a chart for recording the results, together with directions asking him to place the activities in fifty groups with respect to their vigorousness for nursery school children, putting the most vigorous activities in Group 50 and the least vigorous in Group 1. In comparing vigorousness the judges were asked to consider each activity as engaged in for the same period of time.

[1] This study originated at Mills College. Supplementary work has been done at the Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

The Judges

The experimenter chose thirty-two judges who through their training and experience should be competent to rate these activities with the minimum amount of error. Arranging the 651 activities into fifty groups according to their vigorousness is a task which takes from ten to sixteen hours. Results were received from thirteen judges. The ratings of three were discarded because two had not completed the ratings and one had not understood directions.

The ten judges whose ratings were finally used consisted of three psychology professors who were familiar with the preschool, one preschool supervisor, one instructor in physical education who was acquainted with preschool activities, and five graduate students taking work in preschool education. All were well qualified to rate the activities.

Treatment of the Results of the Judges

The ratings of the judges were tabulated and averaged. For each item on the scale the mean group number representing the vigorousness level in which the ten judges had placed the activity was considered the vigorousness of that activity. Since the number of items rated and the number of categories was the same for the ten judges, it was not necessary to change the vigorousness ratings from terms of relative position into measures of unit of amount.

Taking into consideration the probable differences in step intervals between the vigorousness levels on the scale by converting the per cent of times each item was rated more vigorous than each other item into probable error differences between the items would make the scale a little more accurate, but the vast amount of time that this would take did not permit this. Treating the step intervals as if they are equal probably has such a random effect that it does not seriously influence the results.

Distribution of the Activities According to Vigorousness

The activities when grouped according to vigorousness tend to form a normal distribution when the results of the ten judges are used, though the distributions of the individual judges show considerable variation (Figure 1).

Agreement of the Judges

In order to find the consistency of the judges in rating the activities, the coefficient of correlation was found between the mean vigorousness ratings of five of the judges against the ratings of the other five on all of the activities. This coefficient of correlation was .90, which shows that the judges agreed highly in their ratings.

Use of the Rating Scale

The rating scale was used to classify the data, consisting of detailed diary records including each activity in which a child engaged, together with the number

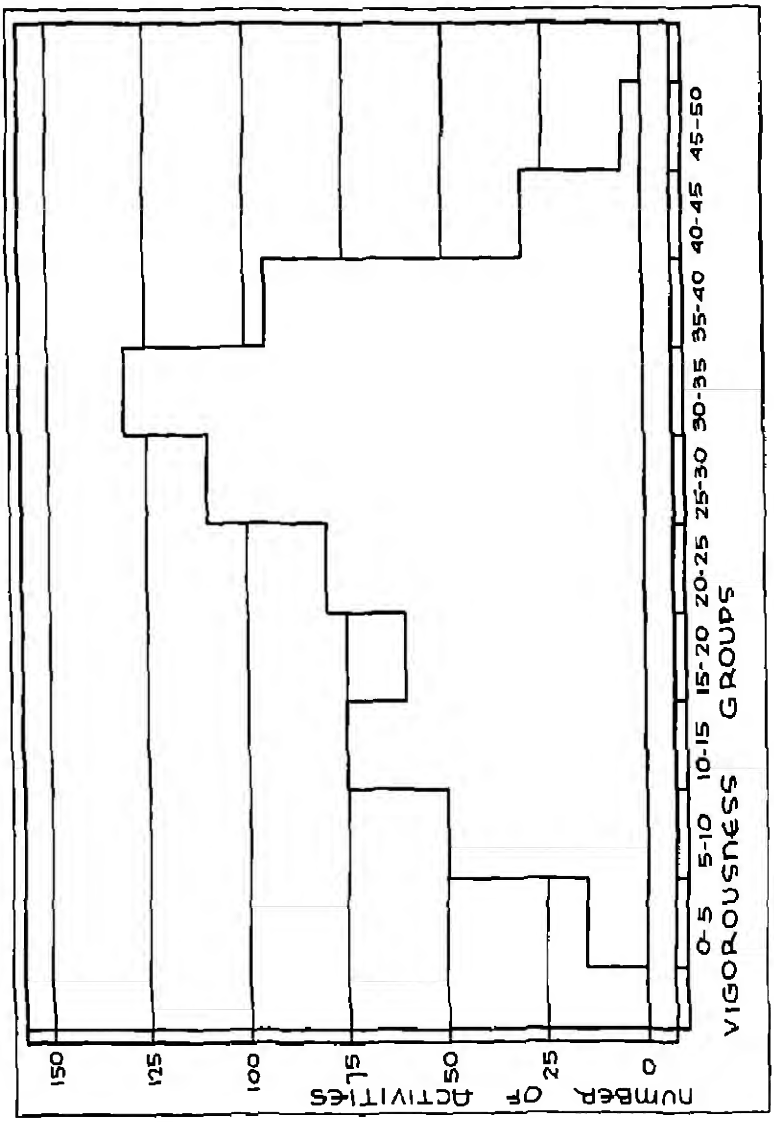

Figure 1. Distribution of the 651 Activities Into Vigorousness Levels as Rated by the Mean of the Ten Judges

of seconds spent at the activity. The diary records were classified by taking each item in the record, finding its duplicate on the rating scale, and multiplying the number of seconds spent as shown on the record by the vigorousness of the activity as indicated on the scale. This product was called the multiplied score, and the sum of the multiplied scores divided by the number of seconds represented was the vigorousness score. Dividing the sum of the multiplied scores by the number of seconds makes it possible to compare vigorousness scores obtained from observations of different length. The vigorousness score can also be compared with individual items on the scale. However, in doing this it must be kept in mind that the child took part in activities both more and less vigorous than the mean score, probably participating over a large range of vigorousness levels.

Following is a short sample of a child's record representing one minute of observation which has been classified:

Item Number	Activity	Time, Seconds	Corrected Multiplier	Vigorousness	Multiplied Score
569	Walking, carrying ball	8		20	160
438	Sitting on ball balancing	7		13	91
537	Standing	2		5	10
568	Walking	3		18	54
560	Running	2		33	66
569	Picking up ball; walking, carrying it	4		20	80
33	Climbing up the steps of the slide one step at a time carrying ball	7	11	31	341
538	Standing at top of slide while ball rolls down chute	3		10	30
69	Rapidly climbing down the chute of the slide	5		37	186
560	Running	11		35	353
568	Walking	18		18	144

The list of activities of the rating scale could be presented in one of two ways. The activities could be listed in their vigorousness levels or they could be listed in categories according to the type of activity, with the vigorousness score for each item. Although the first order of presentation is of interest because it is easy to see items in their comparative vigorousness, the latter order of presentation is necessary in order to make the list of items usable as a rating scale. For this reason the list is presented in this way.

Reliability of the Rating Scale

In order to determine the reliability of the scale, two experienced recorders took data simultaneously. Thirty-four five-minute observations were made. Although the records taken by the two observers showed discrepancies, when they were classified by the rating scale and vigorousness scores were found the correlation between the scores of the two observers was .98 ± .006.

Corrected Multipliers

There is a certain type of item which cannot be scored in the manner just described -- those activities which are self-limiting and more vigorous the less time that it takes to complete them. In this case, it would obviously be wrong to multiply the time by the vigorousness because the multiplied score would be greater the slower the activity. The following example, item 576, walking up stairs one step at a time, makes this clear:

Time, Seconds	Vigorousness	Multiplied Score
6	23	138
5	23	115
4	23	92
3	23	69
2	23	46

If a child took six seconds to walk up the stairs, his total vigorousness for that act would seem to be three times as great as if he had gone up the stairs in two seconds, a performance which obviously would be more strenuous. For these items it was decided to use a system of reversing the time, that is of tabulating all of the time which it took to complete an act, reversing it, and in each case multiplying the vigorousness not by the time but by a corrected multiplier obtained by reversing the time. All of the records, two forty-minute observations for each of thirty-two children, were used in this tabulation. Below is an example of this:

Time, Seconds	Time Reversed	Vigorousness	Multiplied Score
6	2	23	46
5	3	23	69
4	4	23	92
3	5	23	115
2	6	23	138

This system of direct reversal, however, proved to make too great a correction. For this reason multipliers were arranged which would still make the multiplied score greater the less time the activity took, but not as much greater as the simple reversing made it. This was done by finding the median actual time for the

activity and establishing corrected multipliers around it, the multiplier becoming greater as the actual time decreased. To do this it was necessary to do a great deal of experimenting in order to get the multiplier appropriate. The corrected multipliers were tested by multiplying them by the vigorousness of the activity and comparing the product with multiplied scores of other activities engaged in for the same number of seconds. The intervals between the corrected multipliers become greater as the time gets smaller because a difference of one second is more significant in short time periods than in long periods. Following is an example; again item 576, walking up stairs one step at a time, is used:

Time, Seconds	Corrected Multiplier	Vigorousness	Multiplied Score
6	3	23	69
5	3.5	23	80.5
4	4	23	92
3	4.5	23	103.5
2	5	23	115

These corrected multipliers are valid only if the same unit of work is finished in each case. In cases where this is not so, it is necessary to know what proportion of the activity has been completed and to make a correction accordingly. This is discussed later.

For some of the activities which need corrected multipliers there are few data in the diary records. The multipliers for these were made by consulting the time and the multipliers for similar activities which have more data.

Of the 651 activities on the rating scale, there are 113 which are undoubtedly the type which require corrected multipliers. Besides these there are 154 which had to be considered very carefully before a decision could be made. Each of these items was questionable for one of the following reasons:

1. Although the activity was self-limiting, it was seldom completed before the child went to something else.

2. The factor of gravity caused some question. For example, in climbing down the chute of the slide, is it more vigorous to go fast or slowly?

3. The time interval did not vary enough to make corrected multipliers of any value, as in jumping, kicking, and throwing.

4. The activity was apparently more difficult the more slowly it was done (chinning).

Each one of the questionable items was considered carefully and a decision made as to whether it should have corrected multipliers. It was decided that for ninety-seven of these items this would be necessary.

Special Problems in Making the Tables of Corrected Multipliers

In making the tables of corrected multipliers some special problems arose.

1. Some of the activities are stated in such a way that they include two activities, perhaps of different vigorousness. Only the ones for which we have data in the diaries need be considered. Following are these items:

1	Climbing up and down one step of the jungle gym
2	Climbing up and down two or more steps of the jungle gym
159	Climbing in or out of sand box
324	Climbing in or out of wagon
607	Climbing on or off sawhorse
608	Climbing in or out of packing box
609	Climbing on or off packing box
610	Climbing on or off fence
611	Climbing up and down side of porch
612	Climbing on and off window sill
614	Climbing on and off chair or piano bench

In items 159 and 608 both parts of the activity are practically identical in vigorousness, so these were treated in the same way as any other activity with corrected multipliers. For items 1, 2, 609, and 612 a different system was used. It seems quite probable that the climbing down in these activities is less vigorous than the climbing up. The data were taken in such a way that separate times were recorded for each part of the activity, that is, climbing on the packing box was recorded separately from climbing off in item 609. In these cases the times were tabulated separately for each part of the item and separate tables of reversed multipliers were made for each part. The median for climbing on was greater than for climbing off, so that although the same vigorousness was used, the total multiplied score for climbing on in a given length of time was greater than for climbing off in the same length of time. For items 607, 610, 611, and 614 it was not necessary to make separate tables for each part of the activity because in practically every case both parts of the activity were carried out when one was begun.

2. In the vigorousness scale some of the activities are broken up to make two separate items, one for doing the act slowly and one for doing it rapidly. For example:

Item Number	Activity	Vigorousness
94	Slowly walking up incline board	32
95	Rapidly walking up incline board	33

These two items have different vigorousness scores. After tabulating the time taken for completing these activities, there was the question of determining the dividing point between doing the act slowly and doing it rapidly. It was decided

to divide it at the median, using the vigorousness score for doing the activity slowly for all time above the median and for doing it rapidly for all time below. Then the problem arose whether to correct all of the multipliers by reversing around the median or to reverse around the median for completing the activity rapidly and that for completing it slowly. After having tested each method, it seemed more satisfactory to do the former. It was necessary to make a change in the series of corrected multipliers at the median in order that there would not be too great a difference between the multiplied scores of the slowest of the rapid times and the most rapid of the slow times.

3. In a few cases the child only partly completed a self-limiting activity. In these cases the experimenter used the multiplier which would be appropriate if the child had completed the activity at about the same rate of speed. If the child walked halfway up the stairs in three seconds, for example, the corrected multiplier which goes with six seconds was used.

4. Several times activities which ordinarily would be reversed were made continuous by the children. For example, a child climbed up the fence, part way down, up a little way, then down again, continuing fence climbing for some time but not completing the activity of "climbing up the fence" before climbing down. In cases like this, the real times were used rather than the corrected multiplier as if the items were the kind that should not be reversed.

In a few cases children tried to complete an activity for some time without succeeding. For example, a child tried to climb onto a large packing box but could not do so. In cases like this, also, the times were not corrected but the item was treated as one of the nonreversible kind.

Of the 651 activities on the rating scale, 205 are the type which apparently need corrected multipliers. Only fifty-six of these items appear in the diary records. These appear 1,023 times and represent a total of 5 per cent of the total time covered by the records. The method of corrected multipliers is not as objective as the other aspects of the rating scale and may not be entirely accurate, but these items represent such a small proportion of the total time that the effect is probably very small.

At end of the article are the tables of corrected multipliers which were constructed. Many of the activities which needed correction are not represented here, but they apparently appear infrequently in children's activities. If any of them should appear in subsequent records, the experimenter who analyzed the data would have to correct the multiplier as well as possible following the method used in this study. On the rating scale, the items which need corrected multipliers are marked with an asterisk.

THE SUBJECTS

The subjects of this study were thirty-two children, sixteen boys and sixteen girls, paired as nearly as possible according to chronological age. There were not enough children available to make it possible to consider mental ages and IQ's in making the pairings. The subjects ranged in chronological age from 24.0

months to 64.0 months with a mean of 39.9 months. The mental ages ranged from 22.3 months to 61.5 months with a mean of 46.9 months. No intelligence test was obtained on three pairs of children.

Cases were taken from four different preschools in order to have as unselected a group as possible. Seven pairs were taken from the Mills College preschool laboratory. The children were from American homes of above average social status. Six pairs were taken from the Institute of Child Welfare in Berkeley and represent professional families. Two pairs were Italian children, and one pair consisted of Russian twins, all of them from philanthropic preschools of the Golden Gate Kindergarten Association. These children came from homes of low economic status.

THE DATA

Diary records were taken with the aid of a stop watch, indicating each activity engaged in by the child and the number of seconds spent at the activity. The experimenter took the records of twelve children, and two graduate students who were trained to make the observations took records of the other four pairs. Taking the records accurately necessitated great familiarity with the list of activities and experience in making the diaries with the aid of the stop watch.

Since the records were made in order to investigate sex differences, time was equated. Both children of each pair were observed on two consecutive mornings at alternate times -- either during the first part of the morning or during the latter part. That is, if boy A was observed during the first part of the morning on one day and girl A during the latter part, on the following day girl A would be observed first and boy A later.

Each observation was from fifty minutes to one and one-half hours in length depending upon how much it was interrupted by adult suggestion. All items which were affected by adult suggestion were eliminated from the record.

SPECIAL PROBLEMS IN CLASSIFYING DATA

The diary records were classified according to the rating scale as already described. There were a few items in the data which were not found in the rating scale. Most of these could be classified approximately. The items in the scale used as the classification were so similar to those in the diary that it is doubtful that inaccuracy resulted. Following are a few examples of the activities which were only approximately classified.

Item in Record	Classified
Climbing along bar	Going across on jungle gym
Climbing onto stump and off	Climbing onto large packing box
Climbing onto back of bench and off	Climbing on and off of large chair or piano bench

Fifty-nine different activities, appearing 275 times and representing 3,092 seconds or 2 per cent of the data, were approximately classified.

If an item in the diary record could not be classified even approximately on the rating scale, it was discarded. Forty-two different items appearing 101 times in the diary and representing 1,491 seconds or .9 per cent of the total time were discarded because they could not be classified.

Forty minutes were retained for each of the two records on each child except in the case of girl D, whose first hour of observation was 5 minutes, 47 seconds short.

VIGOROUSNESS OF CHILDREN

A final vigorousness score was obtained for each child. These scores ranged from 7.32 to 20.77, the mean being 13.28 with a standard deviation of 3.07. This shows a large variability in the vigorousness of the children.

RELIABILITY OF THE DATA

In order to determine whether two forty-minute observations are enough to give reliable scores, correlations were found between vigorousness scores of the two forty-minute periods of observation. Correlations between the first hour and the second hour observations were .35 for the boys and .18 for the girls. Correlations between Observation I and Observation II were .38 for the boys and .15 for the girls. These are very low correlations and show that there is not only great variability among the members of the group but that each child varies from day to day in the vigorousness of his activities.

These very low correlations suggested that two forty-minute periods are not a large enough sampling of time to obtain reliable results. On the other hand, there was a possibility that the large variation from one day to the next might be much influenced by a child participating in one activity for a long period of time. For this reason correlations were found between the odd and the even five-minute periods throughout the entire eighty minutes of the observations.

For the boys this correlation was .79 ± .09 and for the girls it was .87 ± .06. For both together it was .85 ± .03. When the correlations were corrected by the Spearman-Brown formula, they became .88 for the boys, .93 for the girls, and .92 for both. These are high correlations and indicate that the mean vigorousness scores obtained in this study are reliable.

The results of these correlations also show that forty-minute samples are too long and are likely to be influenced unduly by the possibility of a child staying at one activity during much of the observation period. The method of repeated short samples in taking the data would be more reliable. The correlations shown above indicated that high reliability can be obtained by sixteen five-minute observations even though they are made on two consecutive days, with each half of the observations being consecutive.

SUMMARY AND CONCLUSIONS

1. Using the method of expert judges, a rating scale of the vigorousness of

the activities of preschool children was constructed. The scale consisted of activities ranging in vigorousness level from 1 (not at all vigorous) to 48 (very vigorous).

2. The judges agreed rather highly in rating the activities according to vigorousness. The correlation between the mean ratings of half of the judges against those of the other half was .90.

3. The reliability of the rating scale is high. The correlation between the vigorousness scores obtained from thirty-four consecutive five-minute observations made by two recorders independently though simultaneously was .98.

4. The data consist of detailed diary records taken with the aid of a stop watch. Two forty-minute observations were made on thirty-two preschool children, sixteen boys and sixteen girls paired as to chronological age. When these observations were classified according to the rating scale, it was found that the mean vigorousness score was 13.28.

5. Two forty-minute observations give reliable vigorousness scores as measured by the correlation between odd and even five-minute periods. The correlation is .92 ± .026 when corrected by the Spearman-Brown formula.

6. A study of sex differences in vigorousness of activity of preschool children based upon the use of this rating scale will be reported later.

It seems that this scale might be of value in further research. It would be interesting to determine the relationships between vigorousness scores and such factors as body build, ascendancy or submission, motor control, or length of school attendance.

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN

Item	Activity	Vigorousness
	Activities on the Jungle Gym	
1*	Climbing up or down one step of the jungle gym	22
2*	Climbing up or down two or more steps of the jungle gym	29
3	Going across on jungle gym	28
4	Going diagonally across on jungle gym	29
5	Going diagonally across and up or down on jungle gym	31
6	Standing up on the top bars of the jungle gym, not taking hold of bar for support	18
7	Standing on bar of jungle gym, taking hold	12
8	Standing on bar of jungle gym, taking hold of bar on same level	11
9	Balancing on stomach on bar of jungle gym	20
10	Sitting on bar of jungle gym, taking hold of bar or bars above	11
11	Sitting on bar of jungle gym, taking hold of bar or bars on same level	9
12	Crawling on hands and feet on jungle gym	19
13	Hanging by both hands on bar of jungle gym or other bar	27
14	Hanging by both hands on bar swinging self	32
15	Hanging by both hands on bar being swung by somebody else	28
16	Pulling self up when hanging by arms as in chinning	36
17	Hanging by one hand on bar	27
18	Hanging by one hand on bar swinging self	32
19	Hanging by one hand on bar being swung by somebody else	29
20*	Turning somersault over low bar	32
21	Walking around underneath jungle gym, stepping over low bar	28
	Activities on Slide	
22*	Slowly climbing up one or two steps of the slide one step at a time	22
23*	Rapidly climbing up one or two steps of the slide one step at a time	28
24*	Slowly climbing to top of slide one step at a time	26
25*	Rapidly climbing to top of slide one step at a time	34
26*	Getting to a second step of slide two steps at a time	25
27*	Getting down from the second step of the slide, two steps at a time	24
28*	Slowly climbing to top of slide two steps at a time	27
29*	Rapidly climbing to top of slide two steps at a time	34
30*	Slowly climbing up one or two steps of the slide one step at a time carrying a light object, as a ball, doll, or block	26
31*	Rapidly climbing up one or two steps of the slide one step at a time carrying a light object, as a ball, doll, or block	30
32*	Slowly climbing to top of slide one step at a time carrying a light object, as a ball, doll, or block	27
33*	Rapidly climbing to top of slide one step at a time, carrying a light object, as a ball, doll, or block	31
34*	Getting to second step of slide two steps at a time carrying a light object as a ball, doll, or block	30
35	Getting down from the second step of the slide two steps at a time, carrying a light object as a ball, doll, or block	26
36*	Slowly climbing to the top of the slide two steps at a time, carrying a light object as a ball, doll, or block	31
37*	Rapidly climbing to the top of slide two steps at a time carrying a light object as a ball, doll, or block	36
38*	Slowly climbing down one or two steps of the slide one step at a time	22
39*	Rapidly climbing down one or two steps of the slide one step at a time	29
40*	Slowly climbing down from top of slide one step at a time	27
41*	Rapidly climbing down from top of slide one step at a time	31
42*	Slowly climbing down from top of slide two steps at a time	26

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigor-ousness
43*	Rapidly climbing down from top of slide two steps at a time	29
44*	Slowly climbing down one or two steps of slide one step at a time, carrying a light object as a ball, doll, or block	26
45*	Rapidly climbing down one or two steps of slide one step at a time, carrying a light object as a ball,doll,or block	30
46*	Slowly climbing down from top of slide one step at a time carrying a light object, as a ball, doll, or block	26
47*	Rapidly climbing down from top of slide one step at a time, carrying a light object as a ball, doll, or block	31
48*	Slowly climbing down from top of slide one step at a time, carrying a light object as a ball, doll, or block	28
49*	Rapidly climbing down from top of slide two steps at a time carrying a light object as a ball, doll, or block	33
50*	Getting to a sitting position on top of slide and sliding down frontward	23
51*	Getting to a sitting position on top of slide and sliding down backward	20
52*	Getting on stomach and sliding down slide head first	21
53*	Getting on stomach and sliding down slide feet first	21
54*	Getting on back and sliding down slide head first	23
55*	Getting on back and sliding down slide feet first	21
56	Getting to a sitting position on top of slide and sliding down frontward, holding self back with hands and feet	24
57	Getting to a sitting position on top of slide and sliding down backward, holding self back with hands and feet	24
58	Getting on stomach and sliding down slide head first, holding back with hands and feet	24
59	Getting on stomach and sliding down slide feet first, holding self back with hands and feet	24
60	Getting on back and sliding down slide head first, holding self back with hands and feet	25
61	Getting on back and sliding down slide feet first, holding self back with hands and feet	25
62*	Slowly climbing part way up the chute of the slide when it is slippery	24
63*	Rapidly climbing part way up the chute of the slide when it is slippery	36
64*	Slowly climbing all of the way up the chute of the slide when it is slippery	35
65*	Rapidly climbing all of the way up the chute of the slide when it is slippery	41
66	Slowly climbing part way down the chute of the slide when it is slippery	37
67	Rapidly climbing part way down the chute of the slide when it is slippery	35
68	Slowly climbing all of the way down the chute of the slide when it is slippory	36
69	Rapidly climbing all of the way down the chute of the slide when it is slippery	37
70*	Slowly climbing part way up the chute of the slide when it is not slippery or when child has rubbers on	30
71*	Rapidly climbing part way up the chute of the slide when it is not slippery or when child has rubbers on	36
72*	Slowly climbing all the way up the chute of the slide when it is not slippery or when child has rubbers on	31
73*	Rapidly climbing all the way up the chute of the slide when it is not slippery or when child has rubbers on	35

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
74	Slowly climbing part way down the chute of the slide when it is not slippery or when child has rubbers on	29
75*	Rapidly climbing part way down the chute of the slide when it is not slippery or when child has rubbers on	32
76*	Slowly climbing all the way down the chute of the slide when it is not slippery or when child has rubbers on	31
77*	Rapidly climbing all the way down the chute of the slide when it is not slippery or when child has rubbers on	35
	Activities using the Swings	
78	Sitting, swinging self slightly by pushing with feet	14
79	Sitting, swinging self high by pushing with feet	26
80	Sitting, swinging self slightly using arms and back muscle rather than pushing with feet	19
81	Sitting, swinging self slightly using arm and back muscles and also pushing with feet	21
82	Sitting, swinging self high using arms and back muscles rather than pushing self with feet	28
83	Sitting, swinging self high using arm and back muscles and also pushing with feet	31
84	Standing, swinging self slightly	21
85	Standing, swinging self high	30
86	Swinging empty swing by taking hold of it and walking back and forth	20
87	Swinging empty swing by pushing it	17
88	Swinging child by taking hold of swing and walking back and forth	31
89	Swinging child by pushing swing	28
90	Sitting in swing, turning around and around to twist rope	16
91	Sitting in swing, balancing as twisted rope untwists	11
92	Turning empty swing around and around, twisting the rope	16
93	Turning swing with child in it around and around twisting the rope	25
	Activities Using Incline Board	
94*	Slowly walking up incline board	32
95*	Rapidly walking up incline board	33
96*	Running up incline board	39
97*	Slowly walking up incline board, carrying light object as ball, doll, or block	28
98*	Rapidly walking up incline board, carrying light object as ball, doll, or block	35
99*	Running up incline board, carrying small object as ball, doll, or block	39
100*	Slowly walking up incline board, carrying two or more small objects as ball, doll, or block	29
101*	Rapidly walking up incline board, carrying two or more small objects as ball, doll, or block	35
102*	Running up incline board, carrying two or more small objects as ball, doll, or block	41
103*	Slowly walking up incline board, carrying rather a heavy object as large block	31
104*	Rapidly walking up incline board, carrying rather a heavy object as large block	36
105*	Running walking up incline board, carrying rather a heavy object as large block	42
106*	Slowly walking up incline board, carrying a heavy object as chair, table, or ironing board	34
107*	Rapidly walking up incline board, carrying a heavy object as chair, table, or ironing board	39
108*	Running up incline board, carrying a heavy object as chair, table, or ironing board	48
109*	Slowly walking down incline board	19
110*	Rapidly walking down incline board	27

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
111*	Running down incline board	33
112*	Slowly walking down incline board, carrying a light object as ball, doll, or block	23
113*	Rapidly walking down incline board, carrying a light object as ball, doll, or block	28
114*	Running down incline board, carrying a light object as ball, doll, or block	32
115*	Slowly walking down incline board, carrying two or more light objects as ball, doll, or block	24
116*	Rapidly walking down incline board, carrying two or more small objects, as ball, doll, or block	28
117*	Running down incline board, carrying two or more small objects, as ball, doll, or block	34
118*	Slowly walking down incline board, carrying a rather heavy object, as large block	26
119*	Rapidly walking down incline board, carrying a rather heavy object as large block	32
120*	Running down incline board, carrying a rather heavy object as large block	35
121*	Slowly walking down incline board, carrying a heavy object as chair, table, or ironing board	28
122*	Rapidly walking down incline board, carrying a heavy object as chair, table, or ironing board	34
123*	Running down incline board, carrying a heavy object as chair, table, or ironing board	36
124*	Sitting on incline board and sliding down frontward, helping self along with hands and feet	23
125*	Sitting on incline board and sliding down backward, helping self along with hands and feet	23
126*	Sliding down incline board on stomach head first, helping self along with hands and feet	25
127*	Sliding down incline board on stomach feet first, helping self along with hands and feet	24
128*	Sliding down incline board on back head first, helping self along with hands and feet	23
129*	Sliding down incline board on back feet first, helping self along with hands and feet	23
130	Rolling down incline board	22
131*	Standing, sliding down incline board	27
	Activities on the Seesaw	
132	Sitting on seesaw inactive	3
133	Sitting on seesaw making it go mildly	11
134	Sitting on seesaw making it go vigorously	23
135*	Climbing up seesaw	30
136	Pushing seesaw up and down when not on it, when other children are on it	29
137	Pushing empty seesaw up and down	18
138	Standing, balancing on middle of seesaw when it is moving slightly	17
139	Standing, balancing on middle of seesaw when it is moving vigorously	23
140*	Climbing onto middle of seesaw	25
141*	Climbing onto seesaw when it is low	22
142*	Climbing onto seesaw when it is high	32
	Activities on Climbing Rope	
143	Hanging on climbing rope with both hands	26
144	Hanging on climbing rope with one hand	26
145	Swinging self on climbing rope by using feet to push	33
146	Hanging on climbing rope being swung by somebody else	22
147	Taking hold of climbing rope and walking about	18
148	Taking hold of climbing rope and running about	34
	Activities on Bar**	
149*	Turning somersaults frontward over bar	37
150*	Getting on top of bar and sitting	23

* - Indicates items which take corrected multipliers
** - See also items included under jungle gym

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigor-ousness
151	Getting on bar balancing on stomach	25
	Activities in Sand Box* **	
152	Sitting in outdoor sand box playing quietly	5
153	Sitting in outdoor sand box playing rather vigorously, as digging and pushing sand about strenuously	12
154	Walking about in outdoor sand box, stooping picking up things, etc.	17
155	Standing by indoor sand box, playing quietly	10
156	Moving quickly around or otherwise playing vigorously at indoor sand box	19
157	Standing on edge of sand box	10
158	Walking on edge of sand box	21
159*	Climbing in or out of sand box	17
160	Squatting in sand box playing quietly	7
161	Squatting in sand box playing more vigorously as digging and pushing sand about strenuously	13
	Activities on Walking Board	
162	Balancing on walking board	15
163	Walking and balancing on walking board	20
	Activities on Kiddie Kar or Tricycle	
164	Sitting on tricycle or kiddie kar, inactive	3
165	Sitting on tricycle or kiddie kar, making it move back and forth slightly	8
166	Riding slowly on tricycle or kiddie kar on floor or pavement, using pedals	25
167	Riding rapidly on tricycle or kiddie kar on floor or pavement, using pedals	33
168	Riding slowly on tricycle or kiddie kar on hard ground, using pedals	27
169	Riding rapidly on tricycle or kiddie kar on hard ground, using pedals	32
170	Riding slowly on tricycle or kiddie kar on lawn, using pedals	29
171	Riding rapidly on tricycle or kiddie kar on lawn, using pedals	38
172	Riding slowly on tricycle or kiddie kar through bushes, using pedals	35
173	Riding rapidly on tricycle or kiddie kar through bushes, using pedals	40
174*	Riding slowly on tricycle or kiddie kar up incline board, using pedals	37
175*	Riding rapidly on tricycle or kiddie kar up incline board, using pedals	34
176*	Riding slowly on tricycle or kiddie kar down incline board, using pedals	29
177*	Riding rapidly on tricycle or kiddie kar down incline board, using pedals	33
178	Riding slowly on tricycle or kiddie kar on floor or pavement with other object attached, using pedals	30
179	Riding rapidly on tricycle or kiddie kar on floor or pavement with other object attached, using pedals	36
180	Riding slowly on tricycle or kiddie kar on hard ground with other object attached, using pedals	31
181	Riding rapidly on tricycle or kiddie kar on hard ground with other object attached, using pedals	36
182	Riding slowly on tricycle or kiddie kar on lawn with other object attached, using pedals	31
183	Riding rapidly on tricycle or kiddie kar on lawn with other objects attached, using pedals	38
184	Riding slowly on tricycle or kiddie kar through bushes with other objects attached, using pedals	37
185	Riding rapidly on tricycle or kiddie kar through bushes with other objects attached, using pedals	42
186*	Riding slowly on tricycle or kiddie kar up incline board with other object attached, using pedals	41

* - Indicates items which take corrected multipliers
*** - See also miscellaneous sitting activities

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
187*	Riding rapidly on tricycle or kiddie kar up incline board with other object attached, using pedals	46
188*	Riding slowly on tricycle or kiddie kar down incline board with other object attached, using pedals	32
189*	Riding rapidly on tricycle or kiddie kar down incline board with other object attached, using pedals	33
190	Riding slowly on tricycle or kiddie kar on floor or pavement, carrying object while riding, using pedals	31
191	Riding rapidly on tricycle or kiddie kar on floor or pavement, carrying object while riding, using pedals	35
192	Riding slowly on tricycle or kiddie kar on hard ground, carrying object while riding, using pedals	31
193	Riding rapidly on tricycle or kiddie kar on hard ground, carrying object while riding, using pedals	37
194	Riding slowly on tricycle or kiddie kar on lawn, carrying object while riding, using pedals	33
195	Riding rapidly on tricycle or kiddie kar on lawn, carrying object while riding, using pedals	38
196	Riding slowly on tricycle or kiddie kar through bushes, carrying object while riding, using pedals	36
197	Riding rapidly on tricycle or kiddie kar through bushes, carrying object while riding, using pedals	42
198*	Riding slowly on tricycle or kiddie kar up incline board, carrying object while riding, using pedals	39
199*	Riding rapidly on tricycle or kiddie kar up incline board, carrying object while riding, using pedals	46
200*	Riding slowly on tricycle or kiddie kar down incline board, carrying object while riding, using pedals	30
201*	Riding rapidly on tricycle or kiddie kar down incline board, carrying object while riding, using pedals	33
202	Riding slowly on tricycle or kiddie kar on floor or pavement, not using pedals but pushing with feet	26
203	Riding rapidly on tricycle or kiddie kar on floor or pavement, not using pedals but pushing with feet	30
204	Riding slowly on tricycle or kiddie kar on hard ground, not using pedals but pushing with feet	26
205	Riding rapidly on tricycle or kiddie kar on hard ground, not using pedals but pushing with feet	34
206	Riding slowly on tricycle or kiddie kar on lawn, not using pedals but pushing with feet	30
207	Riding rapidly on tricycle or kiddie kar on lawn, not using pedals but pushing with feet	37
208	Riding slowly on tricycle or kiddie kar through bushes, not using pedals but pushing with feet	33
209	Riding rapidly on tricycle or kiddie kar through bushes, not using pedals but pushing with feet	39
210*	Riding slowly on tricycle or kiddie kar up incline board, not using pedals but pushing with feet	37
211*	Riding rapidly on tricycle or kiddie kar up incline board, not using pedals but pushing with feet	43
212*	Riding slowly on tricycle or kiddie kar down incline board, not using pedals but pushing with feet	27
213*	Riding rapidly on tricycle or kiddie kar down incline board, not using pedals but pushing with feet	31
214	Riding slowly on tricycle or kiddie kar on floor or pavement with other object attached, not using pedals but pushing with feet	29

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
215	Riding rapidly on tricycle or kiddie kar on floor or pavement with other object attached, not using pedals but pushing with feet	36
216	Riding slowly on tricycle or kiddie kar on hard ground with other object attached, not using pedals but pushing with feet	31
217	Riding rapidly on tricycle or kiddie kar on hard ground with other object attached, not using pedals but pushing with feet	38
218	Riding slowly on tricycle or kiddie kar on lawn with other object attached, not using pedals but pushing with feet	34
219	Riding rapidly on tricycle or kiddie kar on lawn with other object attached, not using pedals but pushing with feet	39
220	Riding slowly on tricycle or kiddie kar through bushes with other object attached, not using pedals but pushing with feet	34
221	Riding rapidly on tricycle or kiddie kar through bushes with other object attached, not using pedals but pushing with feet	38
222*	Riding slowly on tricycle or kiddie kar up incline board with other object attached, not using pedals but pushing with feet	39
223*	Riding rapidly on tricycle or kiddie kar up incline board with other object attached, not using pedals but pushing with feet	45
224*	Riding slowly on tricycle or kiddie kar down incline board with other object attached, not using pedals but pushing with feet	27
225*	Riding rapidly on tricycle or kiddie kar down incline board with other object attached, not using pedals but pushing with feet	32
226	Riding slowly on tricycle or kiddie kar on floor or pavement, carrying object while riding, not using pedals but pushing with feet	27
227	Riding rapidly on tricycle or kiddie kar on floor or pavement, carrying object while riding, not using pedals but pushing with feet	35
228	Riding slowly on tricycle or kiddie kar on hard ground, carrying object while riding, not using pedals but pushing with feet	29
229	Riding rapidly on tricycle or kiddie kar on hard ground, carrying object while riding, not using pedals but pushing with feet	36
230	Riding slowly on tricycle or kiddie kar on lawn, carrying object while riding, not using pedals but pushing with feet	34
231	Riding rapidly on tricycle or kiddie kar on lawn, carrying object while riding, not using pedals but pushing with feet	37
232	Riding slowly on tricycle or kiddie kar through bushes, carrying object while riding, not using pedals but pushing with feet	36
233	Riding rapidly on tricycle or kiddie kar through bushes, carrying object while riding, not using pedals but pushing with feet	39
234*	Riding slowly on tricycle or kiddie kar up incline board, carrying object while riding, not using pedals but pushing with feet	40
235*	Riding rapidly on tricycle or kiddie kar up incline board, carrying object while riding, not using pedals but pushing with feet	44
236*	Riding slowly on tricycle or kiddie kar down incline board, carrying object while riding, not using pedals but pushing with feet	30

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
237*	Riding rapidly on tricycle or kiddie kar down incline board, carrying object while riding, not using pedals but pushing with feet	32
238	Slowly pushing or pulling about tricycle or kiddie kar on floor or pavement	25
239	Rapidly pushing or pulling about tricycle or kiddie kar on floor or pavement	31
240	Slowly pushing or pulling about tricycle or kiddie kar on hard ground	26
241	Rapidly pushing or pulling about tricycle or kiddie kar on hard ground	33
242	Slowly pushing or pulling about tricycle or kiddie kar on lawn	28
243	Rapidly pushing or pulling about tricycle or kiddie kar on lawn	34
244	Slowly pushing or pulling tricycle or kiddie kar through bushes	32
245	Rapidly pushing or pulling tricycle or kiddie kar through bushes	31
246	Slowly pushing or pulling about child on tricycle or kiddie kar on floor or pavement	33
247	Rapidly pushing or pulling about child on tricycle or kiddie kar on floor or pavement	38
248	Slowly pushing or pulling about child on tricycle or kiddie kar on hard ground	33
249	Rapidly pushing or pulling about child on tricycle or kiddie kar on hard ground	38
250	Slowly pushing or pulling about child on tricycle or kiddie kar on lawn	37
251	Rapidly pushing or pulling about child on tricycle or kiddie kar on lawn	41
252	Slowly pushing or pulling child on tricycle or kiddie kar through bushes	36
253	Rapidly pushing or pulling child on tricycle or kiddie kar through bushes	42
254*	Slowly pushing or pulling child on tricycle or kiddie kar up incline board	43
255*	Rapidly pushing or pulling child on tricycle or kiddie kar up incline board	47
256*	Slowly pushing or pulling child on tricycle or kiddie kar down incline board	35
257*	Rapidly pushing or pulling child on tricycle or kiddie kar down incline board	37
258	Standing on back bar of tricycle with one foot and slowly pushing self along with other foot	27
259	Standing on back bar of tricycle with one foot and rapidly pushing self along with other foot	28
260*	Slowly pushing or pulling tricycle or kiddie kar up incline board	37
261*	Rapidly pushing or pulling tricycle or kiddie kar up incline board	40
262*	Slowly pushing or pulling tricycle or kiddie kar down incline board	27
263*	Rapidly pushing or pulling tricycle or kiddie kar down incline board	34
264	Slowly pushing or pulling tricycle or kiddie kar about on floor or pavement with other object attached	28
265	Rapidly pushing or pulling tricycle or kiddie kar about on floor or pavement with other object attached	34
266	Slowly pushing or pulling tricycle or kiddie kar about on hard ground with other object attached	28
267	Rapidly pushing or pulling tricycle or kiddie kar about on hard ground with other object attached	34
268	Slowly pushing or pulling tricycle or kiddie kar about on lawn with other object attached	33
269	Rapidly pushing or pulling tricycle or kiddie kar about on lawn with other object attached	38
270	Slowly pushing or pulling tricycle or kiddie kar through bushes with other object attached	36
271	Rapidly pushing or pulling tricycle or kiddie kar through bushes with other object attached	41

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
272*	Slowly pushing or pulling tricycle or kiddie kar up incline board with other object attached	40
273*	Rapidly pushing or pulling tricycle or kiddie kar up incline board with other object attached	41
274*	Slowly pushing or pulling tricycle or kiddie kar down incline board with other object attached	26
275*	Rapidly pushing or pulling tricycle or kiddie kar down incline board with other object attached	33
	Activities with Wagon	
276	Making self go in wagon on floor or pavement not very vigorously	26
277	Making self go in wagon on hard ground not very vigorously	30
278	Making self go in wagon on lawn not very vigorously	32
279	Making self go in wagon through bushes not very vigorously	35
280*	Making self go in wagon up incline board not very vigorously	37
281*	Making self go in wagon down incline board not very vigorously	31
282	Making self go in wagon on floor or pavement vigorously	38
283	Making self go in wagon on hard ground vigorously	36
284	Making self go in wagon on lawn vigorously	38
285	Making self go in wagon through bushes vigorously	43
286*	Making self go in wagon up incline board vigorously	43
287*	Making self go in wagon down incline board vigorously	35
288	Walking while pushing or pulling empty wagon on floor or pavement	23
289	Walking while pushing or pulling empty wagon on hard ground	25
290	Walking while pushing or pulling empty wagon on lawn	25
291	Walking while pushing or pulling empty wagon through bushes	31
292*	Walking while pushing or pulling empty wagon up incline board	34
293*	Walking while pushing or pulling empty wagon down incline board	25
294	Walking while pushing or pulling loaded wagon on floor or pavement	28
295	Walking while pushing or pulling loaded wagon on hard ground	29
296	Walking while pushing or pulling loaded wagon on lawn	29
297	Walking while pushing or pulling loaded wagon through bushes	34
298*	Walking while pushing or pulling loaded wagon up incline board	37
299	Walking while pushing or pulling loaded wagon down incline board	30
300	Walking while pushing or pulling wagon with child in it on floor or pavement	32
301	Walking while pushing or pulling wagon with child in it on hard ground	33
302	Walking while pushing or pulling wagon with child in it on lawn	38
303	Walking while pushing or pulling wagon with child in it through bushes	38
304*	Walking while pushing or pulling wagon with child in it up incline board	42
305*	Walking while pushing or pulling wagon with child in it down incline board	31
306	Running while pushing or pulling empty wagon on floor or pavement	29
307	Running while pushing or pulling empty wagon on hard ground	30
308	Running while pushing or pulling empty wagon on lawn	33
309	Running while pushing or pulling empty wagon through bushes	37
310*	Running while pushing or pulling empty wagon up incline board	40
311	Running while pushing or pulling empty wagon down incline board	33
312	Running while pushing or pulling loaded wagon on floor or pavement	37

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
313	Running while pushing or pulling loaded wagon on hard ground	37
314	Running while pushing or pulling loaded wagon on lawn	39
315	Running while pushing or pulling loaded wagon through bushes	42
316*	Running while pushing or pulling loaded wagon up incline board	34
317*	Running while pushing or pulling loaded wagon down incline board	44
318	Running on floor or pavement while pushing or pulling wagon with child in it	37
319	Running on hard ground while pushing or pulling wagon with child in it	40
320	Running on lawn while pushing or pulling wagon with child in it	42
321	Running through bushes while pushing or pulling wagon with child in it	45
322*	Running up incline board while pushing or pulling wagon with child in it	46
323*	Running down incline board while pushing or pulling wagon with child in it	38
324*	Climbing in and out of wagon; getting on or off tricycle**	25
325	Loading up wagon or wheelbarrow with light object	20
326	Loading up wagon or wheelbarrow with heavy object	27
327	Pushing wagon back and forth while standing	15
328	Pushing wagon back and forth while sitting	10
	Activities with Wheelbarrow	
329	Walking while pushing or pulling empty wheelbarrow on floor or pavement	26
330	Walking while pushing or pulling empty wheelbarrow on hard ground	27
331	Walking while pushing or pulling empty wheelbarrow on lawn	28
332	Walking while pushing or pulling empty wheelbarrow through bushes	33
333*	Walking while pushing or pulling empty wheelbarrow up incline board	33
334	Walking while pushing or pulling empty wheelbarrow down incline board	27
335	Walking while pushing or pulling loaded wheelbarrow on floor or pavement	31
336	Walking while pushing or pulling loaded wheelbarrow on hard ground	33
337	Walking while pushing or pulling loaded wheelbarrow on lawn	34
338	Walking while pushing or pulling loaded wheelbarrow through bushes	37
339*	Walking while pushing or pulling loaded wheelbarrow up incline board	40
340*	Walking while pushing or pulling loaded wheelbarrow down incline board	30
341	Running while pushing or pulling empty wheelbarrow on floor or pavement	35
342	Running while pushing or pulling empty wheelbarrow on hard ground	36
343	Running while pushing or pulling empty wheelbarrow on lawn	36
344	Running while pushing or pulling empty wheelbarrow through bushes	41
345*	Running while pushing or pulling empty wheelbarrow up incline board	41
346*	Running while pushing or pulling empty wheelbarrow down incline board	34
347	Running while pushing or pulling loaded wheelbarrow on floor or pavement	38
348	Running while pushing or pulling loaded wheelbarrow on hard ground	40
349	Running while pushing or pulling loaded wheelbarrow on lawn	40
350	Running while pushing or pulling loaded wheelbarrow through bushes	44
351*	Running while pushing or pulling loaded wheelbarrow up incline board	48
352*	Running while pushing or pulling loaded wheelbarrow down incline board	38
353	Duplicate. See item 325	18
354	Duplicate. See item 326	26
355	Getting in and out of wheelbarrow	21
356	Pushing wheelbarrow back and forth while standing	14
357	Pushing wheelbarrow back and forth while sitting	10

* - Indicates items which take corrected multipliers
** - "Getting on or off tricycle" was added after the scale was completed.

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigor-ousness	Item	Activity	Vigor-ousness
	Activities with Doll Buggy		379	Running through bushes pushing or pulling loaded doll buggy	43
358	Walking on floor or pavement pushing or pulling empty doll buggy	23	380*	Running up incline board pushing or pulling loaded doll buggy	44
359	Walking on hard ground pushing or pulling empty doll buggy	25	381*	Running down incline board pushing or pulling loaded doll buggy	39
360	Walking on lawn pushing or pulling empty doll buggy	27	382	Loading up doll buggy with light objects	19
361	Walking through bushes pushing or pulling empty doll buggy	28	383	Loading up doll buggy with heavy objects	24
362*	Walking up incline board pushing or pulling empty doll buggy	35	384*	Getting in and out of doll buggy	21
363*	Walking down incline board pushing or pulling empty doll buggy	26	385	Pushing doll buggy back and forth while standing	15
364	Walking on floor or pavement pushing or pulling loaded doll buggy	29	386	Pushing doll buggy back and forth while sitting	10
365	Walking on hard ground pushing or pulling loaded doll buggy	29		Activities with Balls	
366	Walking on lawn pushing or pulling loaded doll buggy	32	387	Sitting on floor, throwing small ball a short distance with one hand	9
367	Walking through bushes pushing or pulling loaded doll buggy	37	388	Sitting on floor, throwing small ball as far as possible with one hand	10
368*	Walking up incline board pushing or pulling loaded doll buggy	41	389	Sitting on floor, throwing small ball a short distance with both hands	22
369*	Walking down incline board pushing or pulling loaded doll buggy	32	390	Sitting on floor, throwing small ball as far as possible with both hands	12
370	Running on floor or pavement pushing or pulling empty doll buggy	35	391	Sitting on chair, throwing small ball a short distance with one hand	10
371	Running on hard ground pushing or pulling empty doll buggy	36	392	Sitting on chair, throwing small ball as far as possible with one hand	13
372	Running on lawn pushing or pulling empty doll buggy	36	393	Sitting on chair, throwing small ball a short distance with both hands	9
373	Running through bushes pushing or pulling empty doll buggy	38	394	Sitting on chair, throwing small ball as far as possible with both hands	12
374*	Running up incline board pushing or pulling empty doll buggy	43	395	Standing up, throwing small ball a short distance with one hand	17
375*	Running down incline board pushing or pulling empty doll buggy	35	396	Standing, throwing small ball as far as possible with one hand	17
376	Running on floor or pavement pushing or pulling loaded doll buggy	37	397	Standing up, throwing small ball a short distance with both hands	16
377	Running on hard ground pushing or pulling loaded doll buggy	38	398	Standing up, throwing small ball as far as possible with both hands	18
378	Running on lawn pushing or pulling loaded doll buggy	38	399	Squatting, throwing small ball a short distance with one hand	11
			400	Squatting, throwing small ball as far as possible with one hand	15
			401	Squatting, throwing small ball a short distance with both hands	13

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
402	Squatting, throwing small ball as far as possible with both hands	16
403	Standing, bouncing small ball with one hand	14
404	Standing, bouncing small ball with both hands	16
405	Throwing small ball with one hand and running after it	33
406	Throwing small ball with two hands and running after it	33
407	Bouncing small ball with one hand and running after it	32
408	Bouncing small ball with two hands and running after it	32
409	Throwing small ball to somebody and trying to catch it when it is returned or throwing it against something and trying to catch it when it bounces back	22
410	Kicking small ball about	23
411	Kicking small ball about and running after it	29
412	Sitting on floor, throwing large ball a short distance, with one hand	11
413	Sitting on floor, throwing large ball as far as possible with one hand	12
414	Sitting on floor, throwing large ball a short distance with both hands	11
415	Sitting on floor, throwing large ball as far as possible with both hands	14
416	Sitting on chair, throwing large ball a short distance with one hand	10
417	Sitting on chair, throwing large ball as far as possible with one hand	12
418	Sitting on chair, throwing large ball a short distance with both hands	12
419	Sitting on chair, throwing large ball as far as possible with both hands	13
420	Standing up, throwing large ball a short distance with one hand	16
421	Standing up, throwing large ball as far as possible with one hand	23
422	Standing up, throwing large ball a short distance with both hands	18
423	Standing up, throwing large ball as far as possible with both hands	21
424	Squatting, throwing large ball a short distance with one hand	11
425	Squatting, throwing large ball as far as possible with one hand	15
426	Squatting, throwing large ball a short distance with both hands	14
427	Squatting, throwing large ball as far as possible with both hands	20
428	Standing, bouncing large ball with one hand	15
429	Standing, bouncing large ball with both hands	15
430	Throwing large ball with one hand and running after it	33
431	Throwing large ball with two hands and running after it	34
432	Bouncing large ball with one hand and running after it	33
433	Bouncing large ball with two hands and running after it	34
434	Throwing large ball to somebody and trying to catch it when it is returned or throwing it against something and trying to catch it when it bounces back	23
435	Kicking large ball about	26
436	Kicking large ball about and running after it	31
437	Sitting on large ball	4
438	Sitting on large ball, bouncing up and down	13
439	Balancing on stomach on large ball	15

Activities with Brooms, Rakes, Etc.

Item	Activity	Vigorousness
440	Sweeping with broom by dragging it along floor or ground using one hand	17
441	Sweeping with broom by picking it up as adults do but using only one hand	20
442	Sweeping with broom by dragging it along floor or ground using two hands	20
443	Sweeping with broom by picking it up as adults do using two hands	21
444	Holding dust pan for other person to use	9
445	Using dust pan and broom or brush	19
446	Waving broom about in air	18
447	Using rake or hoe by dragging it around using one hand	17

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigor-ourness
448	Using rake or hoe by picking it up and putting it down as adults do but using only one hand	19
449	Using rake or hoe by dragging it around using two hands	17
450	Using rake or hoe by picking it up and putting it down as adults do but using two hands	20
451	Using garden shovel with one hand	19
452	Using garden shovel with both hands	23
453	Using trowel	11
	Activities with Blocks	
454	Sitting on floor or ground, playing with small blocks or other small objects rather inactively	6
455	Sitting on floor or ground, playing with small blocks or other small objects vigorously, as piling them up, etc.	11
456	Sitting at table, playing with small blocks or other small objects rather inactively	7
457	Sitting at table, playing with small blocks or other small objects vigorously, as piling them up, etc.	9
458	Standing at table, playing with small blocks or other small objects rather inactively	10
459	Standing at table, playing with small blocks or other small objects vigorously, as piling them up, etc.	13
460	Playing with small blocks on floor more actively, i.e., creeping around, kneeling, etc.	14
461	Standing, stooping over, walking about playing with small blocks; picking them up, piling them, etc.	18
462	Sitting on floor or ground, playing with large blocks or other large objects rather inactively	8
463	Sitting on floor or ground, playing with large blocks or other large objects vigorously, as piling them up, etc.	11

Item	Activity	Vigor-ousness
464	Sitting at table, playing with large blocks or other large objects rather inactively	8
465	Sitting at table, playing with large blocks or other large objects vigorously, as piling them up, etc.	10
466	Standing at table, playing with large blocks or other large objects rather inactively	10
467	Standing at table, playing with large blocks or other large objects vigorously, as piling them up, etc.	14
468	Playing with large blocks on floor rather actively, i.e., creeping around, kneeling, etc.	19
469	Standing, stooping over, walking about playing with large blocks; picking them up, piling them, etc.	20
470	Creeping, pushing small block or other small object	15
471	Creeping, pushing large block or other large object	17
472	Walking, stooping over pushing small block or other small object	21
473	Walking, stooping over pushing large block or other large object	24
	Activities with Horse	
474	Sitting astride horse, inactive	3
475	Sitting astride horse with legs out straight along top	9
476	Sitting astride horse with feet on horse's head	7
477	Sitting astride horse with feet on ground or base, using them to make horse go	15
478	Sitting astride horse with feet down but bouncing by using muscles in back	22
479	Sitting astride horse with feet along back of horse, bouncing by using muscles in back	23
480	Sitting astride horse with feet on horse's head, bouncing horse by using muscles in back	24

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Activities with Housekeeping Toys

Item	Activity	Vigorousness
481	Washing clothes by rubbing them together	15
482	Washing clothes by rubbing them on washboard, using one hand	14
483	Washing clothes by rubbing them on washboard, using both hands	18
484	Wringing clothes	15
485	Shaking clothes	15
486	Hanging clothes up	15
487	Folding small garments	9
488	Folding large things	12
489	Putting things in and taking them out of bureau drawers	10
490	Dressing doll	8
491	Undressing doll	7
492	Making doll bed or arranging blankets in doll buggy	12
493	Sitting having tea party, pouring tea, etc.	6
494	Playing house quietly, i.e., sitting, walking about a little, playing dolls, etc.	8
495	Playing house rather actively, as making visits, playing doctor, barber, hospital, etc.	20
496	Vigorous activity as playing robbers, holding door shut to keep out others, chasing, etc.	38
497	Ironing ·	14

Miscellaneous Activity: Sitting Down

Item	Activity	Vigorousness
498	Sitting inactive	2
499	Sitting on floor swaying back and forth, as rocking doll, etc.	7
500	Sitting on floor, manipulating small objects -- not doing anything which requires precision, as playing with small animal, etc., or looking at book	5
501	Sitting on floor, participating in quiet activity which requires precision, as stringing beads, putting pegs in board, drawing, using clay,etc.	7
502	Sitting on floor, participating in rather vigorous activity, as pounding, etc.	15
503	Sitting in chair, swaying back and forth, as rocking doll, etc.	7
504	Sitting at table, manipulating small objects -- not doing anything which requires precision, as playing with small block, animal, etc., or looking at book	5
505	Sitting at table, participating in quiet activity which requires precision, i.e., stringing beads, putting pegs in board, drawing, using clay, etc.	10
506	Sitting at table, participating in rather vigorous activity, as mixing clay, etc.	10
507	Sitting, pounding not very vigorously with hammer or other heavy object	10
508	Sitting, pounding vigorously with hammer or other heavy object	15
509	Sitting, playing piano not very vigorously with one hand	6
510	Sitting, playing piano not very vigorously with both hands	7
511	Sitting, playing piano vigorously with one hand	12
512	Sitting, playing piano vigorously with both hands	13
513	Sitting in rocking chair rocking	7
514	Sitting using saw not very vigorously	9
515	Sitting using saw vigorously	14

Miscellaneous Activity: Kneeling Down

Item	Activity	Vigorousness
516	Kneeling on floor inactive	4
517	Kneeling on floor, swaying back and forth (as rocking doll, etc.)	8
518	Kneeling on floor, manipulating small objects -- not doing anything which requires precision, as playing with small block, animal, etc., or looking at book	8
519	Kneeling on floor, participating in quiet activity which requires precision, as stringing beads, putting pegs in board, drawing, using clay, etc.	9
520	Kneeling on floor, participating in rather vigorous activity, as moving heavy objects about, etc.	18
521	Kneeling on floor, pounding not very vigorously with hammer or other heavy object	12

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
522	Kneeling, pounding vigorously with hammer or other heavy object	15
523	Kneeling, using saw not very vigorously	11
524	Kneeling, using saw vigorously	17
525	Kneeling on chair or bench at table, playing with small blocks or other small objects rather inactively	8
526	Kneeling on chair or bench at table, playing with small blocks or other small objects vigorously, as piling them up, etc.	12
527	Kneeling on chair or bench at table, playing vigorously with large blocks or other large objects	13
	Miscellaneous Activity: Squatting	
528	Squatting on floor, inactive	5
529	Squatting on floor, swaying back and forth (as rocking doll, etc.)	8
530	Squatting on floor, manipulating small objects -- not doing anything which requires precision, as playing with small block, animal, etc., or looking at book	8
531	Squatting on floor, participating in quiet activity which requires precision, i.e., stringing beads, putting pegs in board, drawing, using clay, etc.	9
532	Squatting on floor, participating in rather vigorous activity, as moving about heavy objects	15
533	Squatting, pounding not very vigorously with hammer or other heavy object	11
534	Squatting, pounding vigorously with hammer or other heavy object	17
535	Squatting, using saw not very vigorously	11
536	Squatting, using saw vigorously	17
	Miscellaneous Activity: Standing	
537	Standing inactive	5
538	Standing manipulating small objects -- doing something which does not require precision, i.e., playing with small block or animal or looking at book	10
539	Standing, participating in activity which requires precision, i.e., putting pegs in board, stringing beads, using crayon, clay, etc.	14
540	Standing, pounding not very vigorously with hammer or other heavy object	16
541	Standing, pounding vigorously with hammer or other heavy object	22
542	Standing stooping over, manipulating small objects on floor -- doing something which does not require precision, i.e., playing with small blocks, animal or looking at book	13
543	Standing stooping over, playing with things on floor which require precision, as putting pegs in board, etc.	18
544	Standing stooping over, playing vigorously with things on floor	18
545	Standing at easel, painting or drawing	9
546	Standing, mixing clay not very vigorously	10
547	Standing, mixing clay vigorously	17
548	Duplicate. See item 540	13
549	Duplicate. See item 541	18
550	Standing, using saw not vigorously	13
551	Standing, using saw vigorously	19
552	Standing, using vise not vigorously	12
553	Standing, using vise vigorously	17
554	Standing, playing piano with one hand not very vigorously	11
555	Standing, playing piano with both hands not very vigorously	11
556	Standing, playing piano with one hand vigorously	14
557	Standing, playing piano with both hands vigorously	15
558	Standing, waving arms about not vigorously	11
559	Standing, waving arms about vigorously	18
	Miscellaneous Activity: Running	
560	Running	33
561	Running, carrying light object as ball, doll, or block	35

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
562	Running, carrying two or more light objects as ball, doll, or block	37
563	Running, carrying rather heavy object, as large block	38
564	Running, carrying heavy object, as chair, table, or ironing board	40
565	Running, pushing or pulling small object, as animal on wheels, etc.	37
566	Running, carrying small object and pushing or pulling small object, as animal on wheels	38
567	Running, carrying rather heavy object and pushing or pulling small object, as animal on wheels	39
	Miscellaneous Activity: Walking	
568	Walking	18
569	Walking, carrying light object as ball, doll, or block	20
570	Walking, carrying two or more light objects as ball, doll, or block	21
571	Walking, carrying rather heavy object, as large block	25
572	Walking, carrying heavy object, as chair, table or ironing board	28
573	Walking, pushing or pulling small object, as animal on wheels	25
574	Walking, carrying small object and pushing or pulling small object, as animal on wheels	20
575	Walking, carrying rather heavy object and pushing or pulling small object, as animal on wheels	27
	Miscellaneous Activity: Climbing	
576*	Walking up stairs one step at a time	23
577*	Walking up stairs one step at a time, carrying light object, as ball, doll, or block	26
578*	Walking up stairs one step at a time, carrying two or more light objects, as ball, doll, or block	28
579*	Walking up stairs one step at a time, carrying rather heavy object, as large block	29
580*	Walking up stairs one step at a time, carrying heavy object, as chair, table or ironing board	31
581*	Walking up stairs one step at a time, pushing or pulling small object, as animal on wheels	27
582*	Walking up stairs one step at a time, pushing or pulling small object, as animal on wheels, and carrying light object, as ball, doll, or block	28
583*	Walking down stairs one step at a time	21
584*	Walking down stairs one step at a time, carrying light object, as ball, doll, or block	23
585*	Walking down stairs one step at a time, carrying two or more light objects, as ball, doll, or block	24
586*	Walking down stairs one step at a time, carrying rather heavy object, as large block	27
587*	Walking down stairs one step at a time, carrying heavy objects, as chair, table, or ironing board	31
588*	Walking down stairs one step at a time, pushing or pulling small object, as animal on wheels	27
589*	Walking down stairs one step at a time, pushing or pulling small object, as animal on wheels, and carrying a light object, as ball, doll, or block	28
590*	Walking up stairs two steps at a time	30
591*	Walking up stairs two steps at a time, carrying light object, as ball, doll, or block	34
592*	Walking up stairs two steps at a time, carrying rather heavy object, as large block	34
593*	Walking up stairs two steps at a time, carrying two or more light objects, as ball, doll, or block	32
594*	Walking up stairs two steps at a time, carrying heavy object, as chair, table, or ironing board	35
595*	Walking up stairs two steps at a time, pushing or pulling small object, as animal on wheels	34

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Continued

Item	Activity	Vigorousness
596*	Walking up stairs two steps at a time, pushing or pulling small object, as animal on wheels, and carrying light object, as ball, doll, or block	33
597*	Walking down stairs two steps at a time	29
598*	Walking down stairs two steps at a time, carrying light object, as ball, doll, or block	31
599*	Walking down stairs two steps at a time, carrying rather heavy object, as large block	32
600*	Walking down stairs two steps at a time, carrying heavy object, as chair, table, or ironing board	35
601*	Walking down stairs two steps at a time, pushing or pulling small object, as animal on wheels, etc.	32
602*	Walking down stairs two steps at a time, pushing or pulling small object, as animal on wheels, and carrying light object, as ball, doll, or block	32
603*	Creeping upstairs on hands and knees frontward	22
604*	Creeping upstairs on hands and knees backward	21
605*	Creeping down stairs on hands and knees frontward	22
606*	Creeping down stairs on hands and knees backward	18
607*	Climbing on and off sawhorse	30
608*	Climbing into and out of large packing box	28
609*	Climbing on and off large packing box	29
610*	Climbing on and off fence	31
611*	Climbing up and down side of porch	29
612*	Climbing on and off window sill	29
613*	Climbing on and off outdoor cupboard	28
614*	Climbing on and off large chair or piano bench	23
615*	Climbing up one step of ladder	23
616*	Climbing up one step of ladder, carrying light object, as ball, doll, or block	26
617*	Climbing up one step of ladder, carrying rather heavy object, as large block	30
618*	Climbing up more than one step of ladder one step at a time	29
619*	Climbing up more than one step of ladder one step at a time, carrying light object, as ball, doll, or block	31
620*	Climbing up more than one step of ladder one step at a time, carrying rather heavy object, as large block	32
621*	Climbing up more than one step of ladder two steps at a time	31
622*	Climbing up more than one step of ladder two steps at a time carrying light object, as ball, doll, or block	35
623*	Climbing up more than one step of ladder two steps at a time, carrying rather heavy object, as large block	37
	Other Miscellaneous Activities	
624	Skipping with one foot not waving arms	32
625	Skipping with both feet not waving arms	36
626	Skipping with one foot waving arms	33
627	Skipping with both feet waving arms	37
628	Whirling around and around, not waving arms	33
629	Whirling around and around, waving arms	39
630	Galloping	38
631	Walking on all fours	22
632	Creeping on hands and knees	23
633	Tumbling about	30
634	Rolling on ground or floor	25
635*	Turning somersaults	36
636	Jumping off things, holding on to something	29
637	Jumping off things, not holding on	28
638	Jumping up and down, taking hold of something	32
639	Jumping up and down, not taking hold of something	34
640	Jumping for distance	39
641	Running and jumping	39
642	Hopping	37
643	Throwing miscellaneous objects	19
644	Kicking miscellaneous objects	25
645	Pummelling or wrestling some one mildly	31
646	Pummelling or wrestling some one vigorously	38

* - Indicates items which take corrected multipliers

SCALE OF THE VIGOROUSNESS OF ACTIVITIES OF PRESCHOOL CHILDREN - Concluded

Item	Activity	Vigor-ousness	Item	Activity	Vigor-ousness
647	Lying inactively on floor or bed	1	649	Lying down, kicking not very vigorously	10
648	Lying down, playing quietly, as playing with doll, pulling covers over self, etc.	4	650	Lying down, kicking vigorously	17
			651	Lying down, using arms vigorously	11

CORRECTED MULTIPLIERS

ACTIVITIES WHOSE MULTIPLIERS WERE CORRECTED

Activities With Plenty of Data

Item 2

Up

Time, Seconds	Corrected Multiplier
35	7.0
34	7.2
33	7.3
32	7.3
31	7.3
30	7.4
29	7.4
28	7.4
27	7.4
26	7.5
25	7.5
24	7.5
23	8.0
22	8.0
21	8.0
20	9.0
19	9.0
18	9.5
17	9.5
16	10.0
15	10.5
14	11.0
13	11.5
12*	12.0*
11	12.5
10	13.0
9	13.5
8	14.0
7	15.0
6	16.0
5	17.0
4	18.0
3	19.0

Total cases 17

Down

Time, Seconds	Corrected Multiplier
11	5.5
10	6.0
9	7.0
8*	8.0*
7	9.0
6	10.0
5	11.0
4	12.0
3	13.0

Total cases 16

Vigorousness 29

Item 24

Slowly

Time, Seconds	Corrected Multiplier
45	4.9
28	5.0
27	5.0
26	5.0
25	5.0
24	5.0
23	5.1
22	5.1
21	5.1
20	5.1
19	5.2
18	5.2
17	5.2
16	5.3
15	5.3
14	5.4
13	5.4
12	5.5
11	5.6
10	5.8
9	6.0
8	6.5
7*	7.0*

Vigorousness 26

Item 26

Rapidly

Time, Seconds	Corrected Multiplier
6	[illegible]
5	[illegible]
4	[illegible]
3	[illegible]

Vigorousness 34

Total cases 89

Item 32

Slowly

Time, Seconds	Corrected Multiplier
14	8.2
13	8.5
12	9.0
11	9.5
10*	10.0*

Vigorousness 27

Item 33

Rapidly

Time, Seconds	Corrected Multiplier
9	10.0
8	10.0
7	11.0

Vigorousness 31

Total cases 7

Item 64

Slowly

Time, Seconds	Corrected Multiplier
37	7.0
36	7.2
35	7.2
34	7.4
33	7.6
32	7.8
31	8.0
30	8.0
29	8.5
28	9.0
27	9.5
26	10.0
25	10.5
24	11.0
23	11.5
22	12.0
21	13.0
20	14.0
19	16.0
18*	18.0*

Vigorousness 35

Item 65

Rapidly

Time, Seconds	Corrected Multiplier
17	16.0
16	17.0
15	18.0
14	19.0
13	20.0
12	21.0
11	22.0
10	23.0
9	24.0
8	25.0
7	26.0
6	27.0
5	28.0

Vigorousness 41

Total cases 23

Item 94

Slowly

Time, Seconds	Corrected Multiplier
14	2.4
13	2.6
12	2.8
11	3.0
10	3.5
9	4.0
8	4.5
7	5.0
6*	6.0*

Vigorousness [illegible]

* - Median.

FALES: VIGOROUSNESS OF PLAY

CORRECTED MULTIPLIERS - Continued

ACTIVITIES WHOSE MULTIPLIERS WERE CORRECTED

Activities with Plenty of Data

Item 95

Rapidly

Time, Seconds	Corrected Multiplier
5	6.0
4	7.0
Vigorousness	33
Total cases	36

Item 159

Time, Seconds	Corrected Multiplier
11	2.1
10	2.1
9	2.1
8	2.2
7	2.2
6	2.3
5	2.4
4	2.5
3*	3.0*
2	3.5
1	4.0
Vigorousness	17
Total cases	40

Item 324

Time, Seconds	Corrected Multiplier
19	1.5
18	1.5
17	1.5
16	1.5
15	1.5
14	1.6
13	1.6
12	1.6
11	1.6
10	1.7
9	1.7
8	1.7
7	1.8
6	1.9
5	2.0
4	2.5
3*	3.0*
2	3.5
1	4.0
Vigorousness	25
Total cases	170

Item 576

Time, Seconds	Corrected Multiplier
17	2.4
16	2.4
15	2.4
14	2.4
13	2.5
12	2.5
11	2.5
10	2.6
9	2.6
8	2.7
7	2.8
6	3.0
5	3.6
4*	4.0*
3	4.5
2	5.0
Vigorousness	23
Total cases	96

Item 579

Time, Seconds	Corrected Multiplier
17	5.0
16	5.1
15	5.1
14	5.2
13	5.2
12	5.3
11	5.3
10	5.4
9	5.5
8	6.0
7*	7.0*
6	8.0
5	9.0
4	10.0
Vigorousness	29
Total cases	17

Item 608

Time, Seconds	Corrected Multiplier
29	5.0
28	5.0
27	5.0
26	5.0
25	5.1
24	5.1
23	5.1
22	5.1
21	5.2
20	5.2
19	5.2
18	5.3
17	5.3
16	5.3
15	5.3
14	5.4
13	5.4
12	5.4
11	5.5
10	5.6
9	5.8
8	6.0
7*	7.0*
6	7.5
5	8.0
4	9.0
3	10.0
2	12.0
Vigorousness	28
Total cases	60

Item 609

On

Time, Seconds	Corrected Multiplier
18	2.8
17	2.8
16	2.9
15	2.9
14	3.0
13	3.0
12	3.1
11	3.1
10	3.2
9	3.3
8	3.4
7	3.5
6	4.0
5*	5.0*
4	5.5
3	6.0
2	7.0
1	9.0
Total cases	37

Off

Time, Seconds	Corrected Multiplier
12	1.5
11	1.5
10	1.5
9	1.6
8	1.6
7	1.7
6	1.8
5	1.9
4	2.0
3*	3.0*
2	4.0
1	5.0
Total cases	26
Vigorousness	29

Item 612

Time, Seconds	Corrected Multiplier
14	3.0
13	3.0
12	3.5
11	4.0
10	5.0
9	5.5
8	6.0
7*	7.0*
6	8.0
5	9.0
4	1.0
Vigorousness	29
Total cases	12

Item 614

On

Time, Seconds	Corrected Multiplier
10	2.5
9	3.0
8	3.0
7	3.5
6	4.0
5*	5.0*
4	6.0
3	7.0
2	8.0
Total cases	25

Off

Time, Seconds	Corrected Multiplier
15	.5
14	.5
13	.6
12	.6
11	.7
10	.8
9	.9
8	1.0
7	1.2
6	1.3
5	1.5
4	1.6
3*	3.0*
2	4.0
1	5.0
Total cases	21
Vigorousness	23

* - Median

CORRECTED MULTIPLIERS – Continued

ACTIVITIES WHOSE MULTIPLIERS WERE CORRECTED

<u>Activities for Which There is Little Data</u>

Time, Seconds	Corrected Multiplier
Item 1	
Up	
17	4.0
16	4.0
10	5.5
9	6.0
3	8.0
1	10.0
Total cases	9
Down	
1	4.1
Total cases	4
Vigorousness	22
Items 28 and 29**	
9	7
7	9
Total cases	2
Items 62 and 63#	
20	45
12	6
6	6
Total cases	3
Item 96	
3	2
2	3
Vigorousness	39
Total cases	4
Item 292	
49	7.5
47	7.5
33	8.0
30	8.0
20	8.5
17	9.0
11	10.0
10	11.0

Time, Seconds	Corrected Multiplier
Vigorousness	34
Total cases	9
Item 362	
12	8
7	6
Vigorousness	35
Total cases	2
Item 368	
9	10
Vigorousness	41
Total cases	1
Item 384	
9	9
Vigorousness	21
Total cases	1
Item 577	
11	4.2
8	4.5
7	5.0
6*	6.0*
5	7.0
4	8.0
3	9.0
Vigorousness	26
Total cases	7
Item 580	
5	5
Vigorousness	31
Total cases	2

Time, Seconds	Corrected Multiplier
Item 603	
22	3
9	9
6	10
Vigorousness	22
Total cases	3
Item 607	
10	3
9	3
8	4
6	6
5	7
4	8
Vigorousness	30
Total cases	6
Item 610	
38	13.0
24	14.0
18	14.5
16	16.0
14	18.0
5	22.0
Vigorousness	31
Total cases	8
Item 611	
Both Up and Down	
32	7
31	8
26	9
25	10
15	15
11	19
Just Climbing Up	
18	6
7	8
6	9
Vigorousness	29
Total cases	10

Time, Seconds	Corrected Multiplier
Item 618	
16	8
9	10
Vigorousness	29
Total cases	2

* – Median
** – Vigorousness Score: Slowly, 27; Rapidly, 34
\# – Vigorousness Score: Slowly, 24; Rapidly, 36

CORRECTED MULTIPLIERS - Concluded

ACTIVITIES FOR WHICH THERE IS QUESTION ABOUT REVERSING THE MULTIPLIER

Activities with Plenty of Data

Item 40

Slowly

Time, Seconds	Corrected Multiplier
27	5.0
12	6.6
11	6.8
10	7.0
9	7.5
8*	8.0*
Vigorousness	27

Item 41

Rapidly

Time, Seconds	Corrected Multiplier
7	8.0
6	8.5
5	9.0
4	10.0
Vigorousness	31
Total cases	13

Item 50

Time, Seconds	Corrected Multiplier
26	3.2
25	3.2
24	3.3
23	3.3
22	3.3
21	3.3
20	3.4
19	3.4
18	3.4
17	3.4
16	3.5
15	3.5
14	3.5
13	3.6
12	3.6
11	3.6
10	3.7
9	3.8
8	3.9
7	4.0
6	4.5
5*	5.0*
4	5.5
3	6.0
2	7.0
Vigorousness	23
Total cases	80

Item 51

Time, Seconds	Corrected Multiplier
30	6
10	10
14	14
Vigorousness	20
Total cases	3

Item 52

Time, Seconds	Corrected Multiplier
22	3
16	4
11	4.5
10	5
7	7
Vigorousness	21
Total cases	5

Item 53

Time, Seconds	Corrected Multiplier
23	6
21	6
20	6
12	9
10	10
9	12
6	13
5	14
4	15
Vigorousness	21
Total cases	9

Items 109 and 110**

Time, Seconds	Corrected Multiplier
10	4
9	5
8	6
5	7
4	8
3	9
Total cases	7

Item 111

Time, Seconds	Corrected Multiplier
3	1
2	2
Vigorousness	33
Total cases	19

Item 114

Time, Seconds	Corrected Multiplier
3	3
Vigorousness	32
Total cases	1

Item 124

Time, Seconds	Corrected Multiplier
21	10
6	14
Vigorousness	23
Total cases	2

Item 126

Time, Seconds	Corrected Multiplier
26	6
25	6
15	12
Vigorousness	25
Total cases	3

Item 127

Time, Seconds	Corrected Multiplier
7	15
Vigorousness	24
Total cases	1

Item 129

Time, Seconds	Corrected Multiplier
23	3
22	3
18	4
13	9
11	11
9	13
8	14
Vigorousness	23
Total cases	7

Item 293

Time, Seconds	Corrected Multiplier
5	6
6	5
Vigorousness	25
Total cases	2

Item 363

Time, Seconds	Corrected Multiplier
6	6
12	9
Vigorousness	26
Total cases	2

Item 369

Time, Seconds	Corrected Multiplier
11	7
Vigorousness	32
Total cases	1

Item 583

Time, Seconds	Corrected Multiplier
19	3.3
15	3.4
14	3.4
13	3.5
12	3.5
11	3.5
10	3.5
9	3.6
8	3.7
7	3.8
6	4.0
5*	5.0*
4	6.0
3	7.0
2	8.0
Vigorousness	21
Total cases	93

Item 584

Time, Seconds	Corrected Multiplier
10	3
6	4
5	5
4	6
3	7
Vigorousness	23
Total cases	5

Item 586

Time, Seconds	Corrected Multiplier
14	2.0
13	2.0
12	2.1
11	2.1
10	2.2
9	2.2
8	2.3
7	2.4
6	2.5
5	3.0
4*	4.0*
3	5.0
2	6.0
Vigorousness	27
Total cases	12

* - Median

** - Vigorousness Scores: Slowly, 19; Rapidly, 27.

ANTHROPOMETRIC STUDIES OF INDIVIDUAL GROWTH
II. AGE, WEIGHT, AND RATE OF GROWTH IN WEIGHT, ELEMENTARY SCHOOL CHILDREN

CARROLL E. PALMER, RIITI KAWAKAMI AND LOWELL J. REED [1]

In a recent paper [2] an analysis was presented of seriatim or "longitudinal" measurements of the height of elementary school children to show the relationship between height already attained and the average annual rate of growth in height. It was shown that:

1. For boys, average annual gains in height decrease regularly from the sixth through the tenth year of age. During this period increments of height are largely independent of height already attained. The well known "adolescent acceleration" of growth, regardless of age, begins somewhat abruptly when boys reach a height of 52 to 53 inches. During this accelerated phase of growth, which continues until a stature of at least 60 to 61 inches is reached, there is a marked positive correlation between the average rate of growth and attained height.

2. For girls, average annual gains in height decrease regularly from the sixth through the ninth year and these gains are independent of attained height. The adolescent acceleration of growth in girls begins when a height of 50 to 51 inches is reached and continues until a stature of 55 to 56 inches is reached. With the attainment of the latter stature there is a marked decrease in growth rates. Throughout the whole of the adolescent period there is a definite association between growth in height and height itself.

3. During the adolescent accelerated phase of growth there is a slight positive association, more marked for girls than for boys, between height and variability of gain in height during the following year.

It is the purpose of this paper to present a similar analysis of seriatim weighings of elementary school children in order to show the relationship between attained weight and average annual growth in weight. More specifically, it is proposed to answer two questions: First, is the annual rate of growth in weight related to absolute weight at the beginning of the year and, if so, does this relationship change with chronological age? Or, expressed differently, are the annual rates of growth in weight a function of attained weight only, attained age only, or of both attained weight and age? Second, to what extent do individuals,

[1] From the Office of Child Hygiene, U. S. Public Health Service and the Department of Biostatistics (Paper No. 210), The Johns Hopkins School of Hygiene and Public Health. Grateful acknowledgment is made for assistance in various parts of the study to Selwyn D. Collins, Morton Kramer and Jacob Yerushalmy. This is the eighth in a series of papers published under the general title, "Hagerstown Growth Studies." Reference to the earlier papers will be found in: Selective Mortality in Childhood, Am. Jour. Hygiene, 21: 605-612. 1935.

[2] Palmer, Carroll E., and Reed, Lowell J. Anthropometric Studies of Individual Growth. I. Age, Height, and Growth in Height, Elementary School Children. Human Biology, 7: 319-324. 1935.

TABLE 1

CONSTANTS OF FREQUENCY DISTRIBUTIONS OF ANNUAL GAINS[1] IN WEIGHT FOR SPECIFIED AGES AND WEIGHTS, ELEMENTARY SCHOOL BOYS, HAGERSTOWN, MARYLAND

Weight Classes[3] lbs	AGE CLASSES[2] 6 - 7			7 - 8			8 - 9			9 - 10			10 - 11			11 - 12			12 - 13			13 - 14			All Ages		
	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases	Mean lbs	Stand Dev lbs	No of Cases
32	3.85	0.85	3	9.00	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.13	0.64	4
36	4.21	1.67	28	4.22	1.82	25	3.33	1.43	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.17	1.77	56
40	4.33	1.35	56	4.40	1.30	78	4.97	1.90	32	3.56	1.01	8	5.75	2.63	3	4.75	-	1	-	-	-	-	-	-	4.47	1.40	176
44	4.85	1.60	66	5.16	1.51	121	4.57	1.51	99	5.20	2.64	40	2.50	3.49	4	2.75	-	1	-	-	-	-	-	-	4.88	1.68	331
48	5.65	3.19	38	5.12	1.74	132	4.68	1.39	139	4.71	1.72	95	5.22	2.50	32	4.25	1.12	4	4.75	1.00	2	-	-	-	4.94	1.95	443
52	6.00	2.98	17	5.75	2.37	73	5.78	1.69	172	5.38	1.55	135	5.44	2.00	70	4.94	2.28	21	4.73	1.41	3	8.76	-	1	5.58	1.94	492
56	6.33	0.85	3	5.59	2.24	35	5.69	2.45	125	5.90	1.91	149	5.67	1.61	130	4.83	1.57	48	4.08	2.36	9	3.08	2.87	3	5.63	1.96	502
60	-	-	-	7.03	2.61	15	6.56	1.92	57	5.86	1.98	154	6.13	2.38	160	5.41	1.84	80	7.01	3.25	31	6.75	2.38	6	5.96	2.18	505
64	-	-	-	3.75	4.97	4	6.66	3.15	31	5.45	2.23	110	6.05	2.35	124	6.46	2.47	113	5.90	2.23	52	6.33	3.28	12	6.02	2.44	448
68	16.00	-	1	-	-	-	6.90	3.15	10	7.43	3.09	50	6.67	2.74	98	6.94	3.03	97	6.61	2.99	59	7.07	2.82	22	6.91	2.93	337
72	-	-	-	-	-	-	8.44	5.24	8	7.39	3.08	31	7.44	3.83	58	7.94	4.18	97	8.05	4.12	79	9.96	5.36	28	8.02	4.15	301
76	-	-	-	-	-	-	7.40	4.04	5	10.40	4.66	10	7.88	3.91	31	9.55	4.37	54	9.16	4.62	54	10.29	4.88	46	9.34	4.54	200
80	-	-	-	-	-	-	-	-	-	12.80	4.54	6	8.07	4.68	22	8.65	4.58	43	9.00	4.37	53	10.83	5.31	25	9.14	4.64	148
84	-	-	-	-	-	-	-	-	-	12.00	0.50	2	11.00	4.37	16	11.46	6.15	17	11.84	5.57	32	11.75	4.47	32	11.61	5.34	99
88	-	-	-	-	-	-	25.50	-	1	-	-	-	11.75	4.06	4	11.58	6.14	12	12.31	5.91	25	16.61	5.68	21	13.78	5.68	63
92	-	-	-	-	-	-	-	-	-	8.83	3.47	3	9.08	4.96	6	9.95	7.38	13	14.54	6.41	14	11.84	6.57	23	11.63	6.39	59
96	-	-	-	-	-	-	-	-	-	7.25	2.25	2	7.75	-	1	11.89	5.72	7	15.00	8.21	12	12.21	4.63	13	12.69	5.12	35
100	-	-	-	-	-	-	-	-	-	-	-	-	15.75	1.41	3	16.00	9.01	4	15.75	3.57	8	16.31	5.87	9	16.00	6.07	24
104	-	-	-	-	-	-	-	-	-	-	-	-	8.75	-	2	12.75	4.00	5	9.00	1.79	4	16.58	10.23	6	12.75	5.21	17
108	-	-	-	-	-	-	-	-	-	17.25	4.25	2	-	-	-	11.25	1.50	2	0.25	17.00	2	15.38	2.12	8	12.82	4.60	14
112	-	-	-	-	-	-	-	-	-	20.60	-	1	-	-	-	15.25	4.11	6	18.75	3.27	3	14.00	3.35	4	16.02	3.42	14
116	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.25	8.50	2	16.75	2.16	3	17.75	4.70	5
120	-	-	-	5.50	-	1	-	-	-	-	-	-	-	-	-	22.75	-	1	14.25	2.50	2	13.75	-	1	14.10	1.00	5
124	-	-	-	-	-	-	-	-	-	-	-	-	19.75	-	1	-	-	-	17.25	2.50	2	-	-	-	18.08	1.67	3
128	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.75	-	1	-	-	-	-	-	-	12.75	-	1
132	-	-	-	-	-	-	-	-	-	-	-	-	22.25	0.50	2	-	-	-	14.42	2.06	3	21.75	5.72	3	19.13	3.04	8
136	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19.75	-	1	19.75	-	1
140	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21.75	4.00	2	18.75	1.00	2	20.25	2.50	4
144	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.75	-	1	-	-	-	-	-	-	14.75	-	1
148	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
152	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
156	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25.75	-	1	-	-	-	-	-	-	25.75	-	1
160	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25.75	-	1	-	-	-	25.75	-	1
164	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21.75	-	1	21.75	-	1
168	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
172	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
All Weights	4.90	1.88	212	5.15	1.80	485	6.46	2.02	682	5.65	2.14	798	6.48	2.56	767	7.49	3.31	629	8.96	4.14	454	11.49	4.72	270			

1 Gains are calculated as the difference between weighings made in October each year from 1921 through 1927. The means of the gains represent increases in weight although the individual increments of some of the children represent actual losses in weight. No observations were omitted in these calculations.

2 The first number of the age class represents the age on the birthday nearest to January 1 of the year for which the increments were calculated. For example, the age class 6-7 represents a group of children who were 6 years of age at their birthday nearest January 1 between the two October weighing days.

3 The figures given for the weight classes represent a range of weights which begin with the weight class recorded and extend to, but not inclusive of, the weight in the class next below.

TABLE 2

CONSTANTS OF FREQUENCY DISTRIBUTIONS OF ANNUAL GAINS[1] IN WEIGHT FOR SPECIFIED AGES AND WEIGHTS.
ELEMENTARY SCHOOL GIRLS, HAGERSTOWN, MARYLAND

Weight Classes[3] lbs	AGE CLASSES[2] 6 - 7 Mean lbs	6 - 7 Stand Dev lbs	6 - 7 No of Cases	7 - 8 Mean lbs	7 - 8 Stand Dev lbs	7 - 8 No of Cases	8 - 9 Mean lbs	8 - 9 Stand Dev lbs	8 - 9 No of Cases	9 - 10 Mean lbs	9 - 10 Stand Dev lbs	9 - 10 No of Cases	10 - 11 Mean lbs	10 - 11 Stand Dev lbs	10 - 11 No of Cases	11 - 12 Mean lbs	11 - 12 Stand Dev lbs	11 - 12 No of Cases	12 - 13 Mean lbs	12 - 13 Stand Dev lbs	12 - 13 No of Cases	13 - 14 Mean lbs	13 - 14 Stand Dev lbs	13 - 14 No of Cases	All Ages Mean lbs	All Ages Stand Dev lbs	All Ages No of Cases
32	3.83	0.24	3	4.25	1.25	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.11	.81	9
36	4.55	1.44	31	4.60	1.47	28	3.84	1.10	8	6.00	.50	2	-	-	-	-	-	-	-	-	-	-	-	-	4.47	1.38	67
40	4.38	1.58	68	4.08	1.81	101	4.27	1.62	33	3.98	1.48	12	2.75	-	1	2.75	-	1	-	-	-	-	-	-	4.18	1.67	222
44	4.63	1.93	64	4.68	1.70	164	4.81	1.85	124	4.28	1.65	38	3.80	1.73	19	4.42	.48	3	1.75	-	1	8.75	-	1	4.63	1.79	414
48	4.90	2.13	20	5.09	2.34	128	4.93	1.83	178	4.77	2.09	128	5.15	1.94	45	4.90	3.03	13	6.85	2.04	5	-	-	-	4.97	2.09	515
52	6.50	1.08	4	5.61	2.03	63	6.49	2.18	123	5.34	2.32	152	6.74	2.66	89	6.61	2.60	29	7.39	4.35	11	6.75	-	1	5.57	2.36	462
56	4.17	2.12	3	7.09	3.55	17	6.38	2.93	76	6.05	3.05	171	6.43	2.80	137	6.68	3.23	65	8.11	2.31	22	5.75	2.16	3	6.40	2.98	494
60	-	-	-	5.59	4.67	8	7.03	3.83	44	6.70	2.47	96	6.99	2.94	144	7.36	3.18	80	8.58	3.52	28	9.75	1.41	7	7.12	3.03	405
64	1.00	-	1	-	-	-	8.03	3.01	16	8.08	4.69	47	8.31	4.03	108	9.41	3.43	78	9.22	3.10	55	10.33	3.15	19	8.77	3.74	322
68	-	-	-	12.00	2.12	3	10.92	3.86	12	8.24	3.85	32	9.07	3.14	69	9.27	3.94	94	9.76	3.60	45	11.56	3.25	18	9.43	3.62	261
72	-	-	-	10.00	2.50	2	11.38	3.25	4	7.28	4.40	9	10.44	4.88	48	11.68	4.38	69	12.13	4.00	40	12.85	4.33	21	11.37	4.37	185
76	-	-	-	-	-	-	13.50	-	1	9.77	5.60	11	11.02	5.60	22	12.08	4.24	52	12.69	4.08	51	12.22	3.42	19	11.99	4.33	156
80	-	-	-	-	-	-	11.50	-	1	12.50	4.19	7	10.90	5.68	13	13.33	5.43	31	13.17	4.30	36	12.46	3.49	14	12.70	4.69	102
84	-	-	-	-	-	-	9.17	2.08	3	16.50	6.66	4	12.08	3.59	4	14.20	4.99	29	14.05	5.05	30	12.60	4.20	20	13.60	4.72	92
88	-	-	-	-	-	-	-	-	-	9.75	1.31	2	12.35	4.03	5	13.18	5.98	14	12.07	6.06	22	11.25	3.91	14	12.08	5.17	57
92	-	-	-	-	-	-	14.00	-	1	6.17	11.29	3	15.00	7.05	8	13.61	5.08	7	13.71	6.84	22	12.18	5.27	30	12.88	6.12	71
96	-	-	-	-	-	-	-	-	-	4.75	0.25	2	14.08	4.11	3	15.42	6.80	3	15.22	6.17	16	10.84	4.01	11	13.10	5.00	34
100	-	-	-	-	-	-	-	-	-	-	-	-	14.75	2.19	6	17.76	5.42	8	12.85	7.06	10	11.69	7.31	18	13.43	6.24	57
104	-	-	-	-	-	-	-	-	-	-	-	-	19.25	2.60	2	12.76	2.90	5	10.63	5.04	8	13.63	3.98	8	12.88	3.98	23
108	-	-	-	-	-	-	-	-	-	-	-	-	11.75	-	1	17.25	8.50	2	10.42	7.78	6	17.19	6.69	9	14.64	6.83	18
112	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.50	6.87	4	14.75	-	1	8.89	3.83	7	10.26	4.63	12
115	-	-	-	-	-	-	-	-	-	19.00	-	1	-	-	-	21.75	6.00	2	16.25	5.50	2	9.76	9.14	5	14.78	6.87	10
120	-	-	-	-	-	-	-	-	-	-	-	-	8.76	-	1	-	-	-	-	-	-	19.00	1.79	4	16.86	1.43	5
124	-	-	-	-	-	-	-	-	-	-	-	-	12.76	-	1	23.75	-	1	-	-	-	14.75	-	1	20.42	-	3
128	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16.25	3.50	2	-	-	-	8.75	1.41	3	11.77	2.25	5
132	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	28.75	-	1	28.75	-	1
136	-	-	-	-	-	-	-	-	-	-	-	-	8.76	-	1	19.76	-	1	-	-	-	-	-	-	14.25	-	2
140	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
144	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
148	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.75	-	1	13.75	-	1
152	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22.75	-	1	-	-	-	22.75	-	1
156	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-.25	-	1	-.25	-	1
160	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.75	-	1	-	-	-	10.75	-	1
164	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
168	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
172	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16.75	-	1	-	-	-	6.25	-	1	5.75	-	2
All Weights	4.55	1.56	194	4.90	2.02	512	5.69	2.29	624	6.08	2.77	717	7.52	3.26	718	9.87	3.91	590	11.34	4.27	410	11.88	4.15	233			

1 Gains are calculated as the difference between weighings made in October each year from 1921 through 1927. The means of the gains represent increases in weight although the individual increments of some of the children represent actual losses in weight. No observations were omitted in these calculations.

2 The first number of the age class represents the age on the birthday nearest to January 1 of the year for which the increments were calculated. For example, the age class 6-7 represents a group of children who were 6 years of age at their birthday nearest January 1 between the two October weighing days.

3 The figures given for the weight classes represent a range of weights which begin with the weight class recorded and extend to, but not inclusive of, the weight in the class next below.

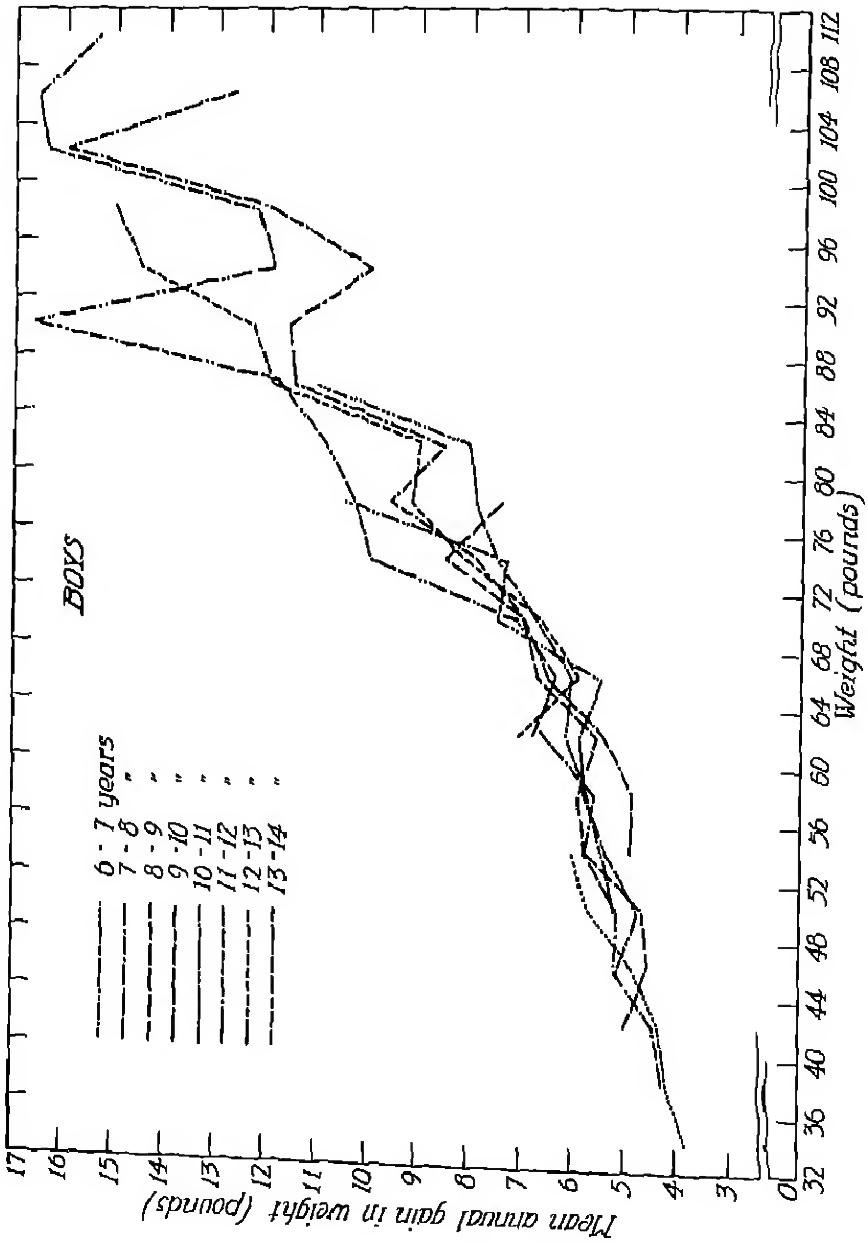

Figure 1. Mean annual rates of growth in weight, specific for age and attained weight.

alike with respect to weight at one age, tend to become different after a year of growth? Or, in other words, what is the dispersing effect of growth?

MATERIAL

The basic material for this paper was derived from the records of an investigation of the growth and health of school children made at Hagerstown, Maryland, by the Child Hygiene Office of the U.S. Public Health Service during a seven year period from 1921 through 1927. Records were made of annual weighings of approximately 2,500 white, native-born, elementary school boys and girls in the month of October of each year. Some of these children were measured twice, some three times, and so on; a few were measured seven times. From these observations it was possible to abstract over 8,000 actual yearly increments of gain in body weight for children between 6 and 14 years of age. Limitation of the study to children between these ages was made although increments were available for children considerably above 14 years of age. This limitation was considered essential because of the well known fact that over-age-for-grade children, such as those who are over 14 years of age in the elementary school, form a selected group with respect to their physical and other characteristics. The inclusion of children in their 13th year, however, would appear to introduce no selective factors which would seriously effect the results of the study. Inclusion of six year old children, who are in school, probably introduces some selective elements since there is some differentiation with respect to physical characteristics of children admitted to the first grade. In view of the fact, however, that the same selective factors generally are operative in all studies of elementary school children, it was considered permissible to include data from all children in the lower age groups. The data, although from selected children, are therefore considered representative of the first eight grades of the elementary school population since the only important selective elements are those which would require a child to be present in school on the days when the annual weighings were made in October. It was not feasible in a study of this magnitude to weigh the children at exactly yearly intervals and the increments were adjusted by simple arithmetic interpolation to cover twelve-month periods. With few exceptions, however, the intervals between measurements were between 11 and 13 months. The dates of birth of the children were obtained from the school records; the age used for each incremental period was the age on the birthday nearest to January first between the consecutive October weighings. Approximately 90 percent of the weighings were made by one individual; the beam scales which were used were carefully calibrated and it may be assumed that errors due to the "personal equation" were of minor importance. Weights were recorded to the nearest quarter pound, and, during the measuring, the children were required to remove shoes, vests, sweaters and coats.

METHOD OF ANALYSIS

The method of analysis is essentially one of correlation, the particular relationship of interest being that between attained weight at the beginning of the year and gain in weight during the following year. Thus, the records of the children were grouped in age and sex specific classes and then into 4-pound sub-groups according to weight at the beginning of the year. Two constants were then calculated for the children in each of the sub-groups; first, the average annual gain

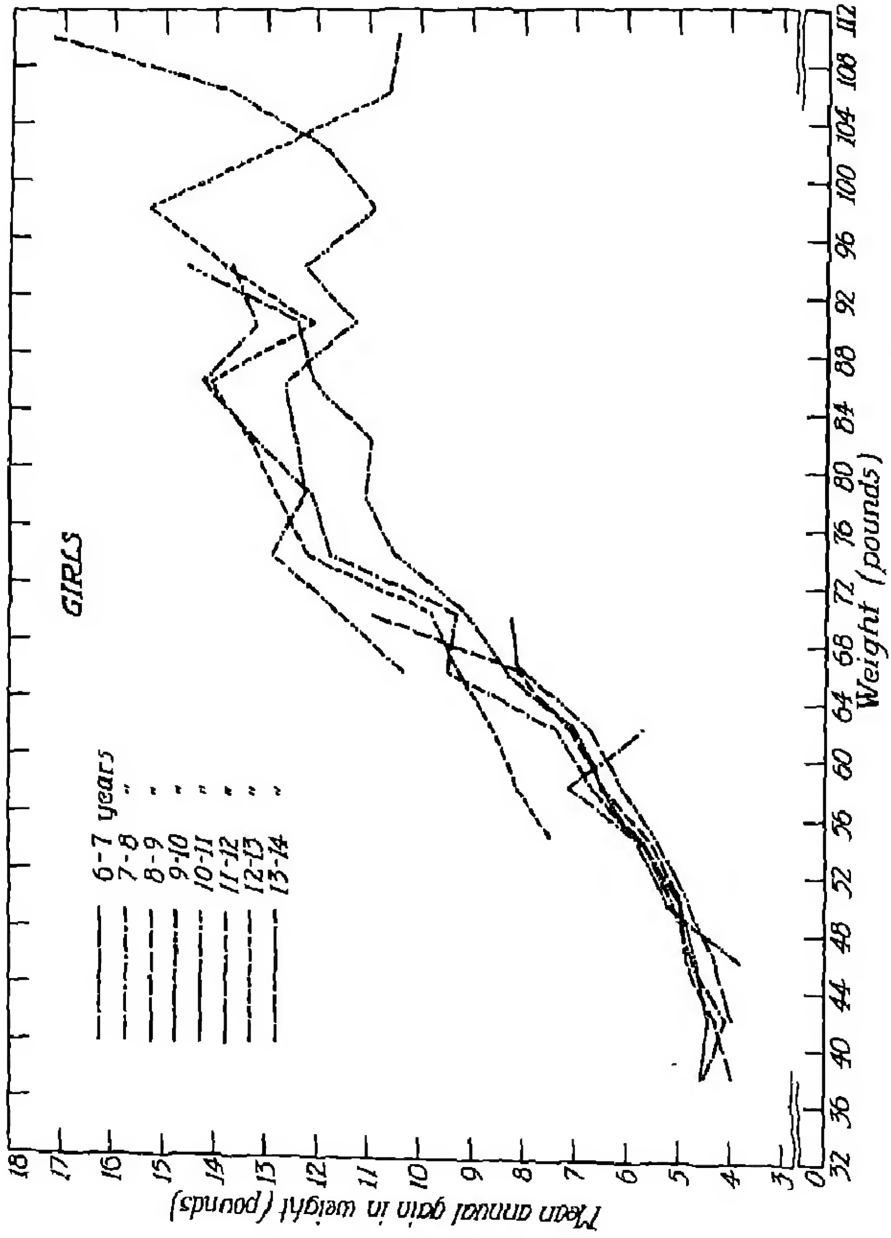

Figure 2. Mean annual rates of growth in weight, specific for age and attained weight.

in weight during the following year and, second, the standard deviation of the annual gains.

Basic data showing the average and standard deviation of annual gains and the number of children for each age and sex and weight subgroup are shown in Tables 1 and 2. A specific example of the method of reading the values given in these tables may facilitate their interpretation. In the upper left hand section of Table 1, to the right of the marginal heading "32" and below the heading "6-7", are given three items: the mean, the standard deviation "Stand Dev" and the number of cases "No" for the group whose age was six years at the beginning of the year and was seven years at the end of that period. The figures given there show that three boys, whose weights in October were 32 pounds but less than 36 pounds and whose age at their nearest birthdays on the following January first was six years, gained between the two successive October weighings an average of 3.83 pounds and that the standard deviation for the distribution of gains of these three boys equalled 0.85 pounds. The numbers given in the lowest horizontal row in Tables 1 and 2 are the weighted mean gains, the average weighted standard deviations[3] of gains and number of children for each of the age classes, irrespective of the actual weight of the children at those ages. The numbers given in the vertical columns at the extreme right of the tables are, similarly, the weighted mean gains, the average weighted standard deviations[3] and the number of individuals, for groups of children of the same weight, irrespective of age.

In order to provide statistical data of possible use to future workers, Table 3 gives the means, standard deviations and numbers of cases for the distribution of actual body weights for children in the different age classes. These data, together with those given in the marginal arrays of Tables 1 and 2, furnish the essential constants needed to reconstruct the principal parts of the correlation tables on which the paper is based.

TABLE 3

Constants of Frequency Distributions of Observed Weights for Specific Ages. Elementary School Children, Hagerstown, Maryland

Age	Boys			Girls		
	Mean lbs	Stand Dev	No	Mean lbs	Stand Dev	No
6	45.45	5.11	212	44.04	4.60	194
7	48.93	6.57	485	47.36	5.58	512
8	54.12	7.04	682	52.62	7.24	624
9	59.75	8.75	798	57.69	8.75	717
10	65.21	10.32	767	63.60	11.08	718
11	71.82	12.52	629	70.99	13.81	590
12	78.44	14.18	454	77.42	14.88	410
13	85.26	15.65	270	88.51	18.81	233

[3] These standard deviations are simply the averages of those given in the appropriate arrays, weighted for the number of cases from which the individual standard deviations were calculated.

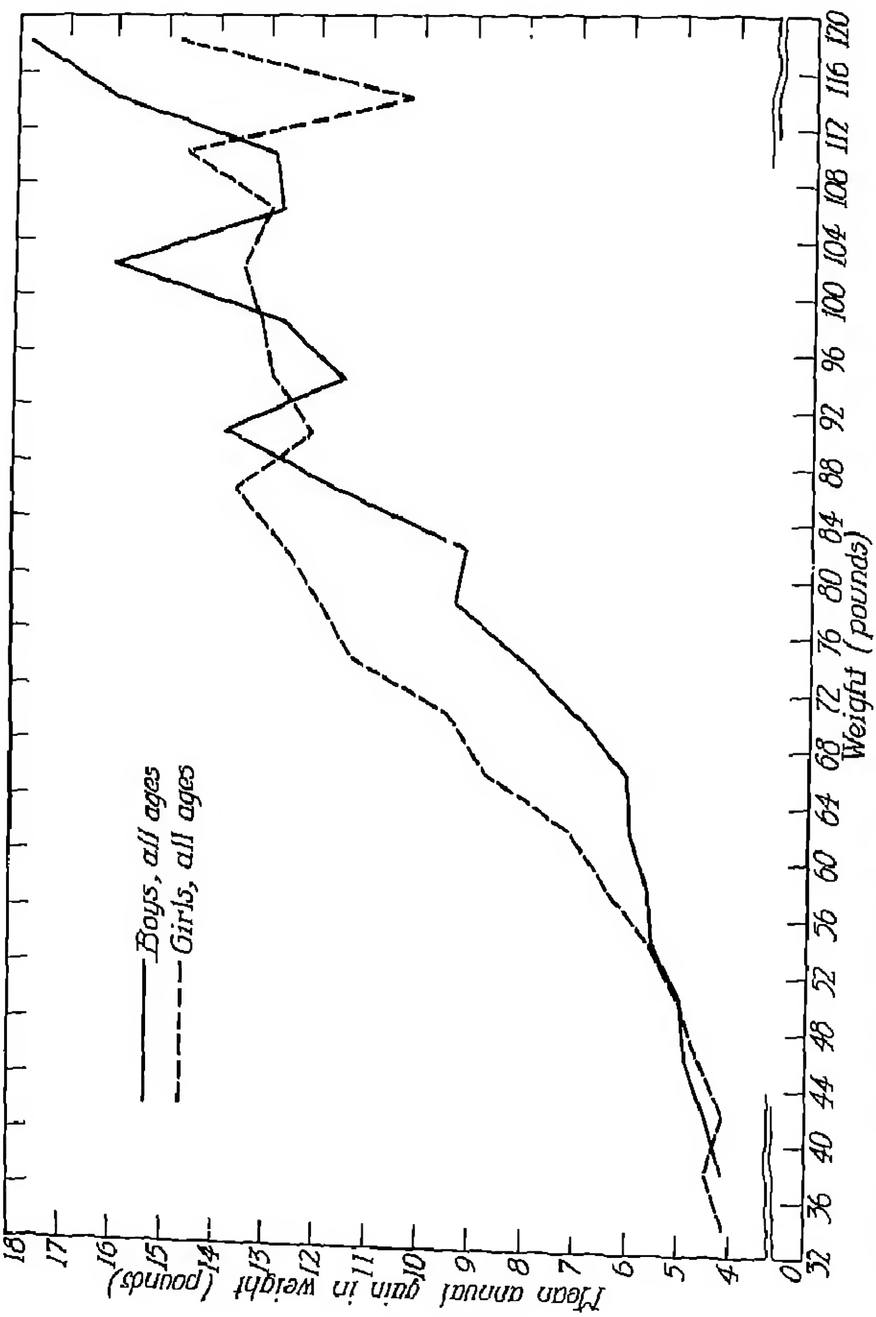

Figure 3. Mean annual rates of growth in weight, specific for attained weight. All ages, 6 through 13 years.

MEAN ANNUAL RATE OF GROWTH

The relationship between weight attained at a given age and average gain in weight during the following year is shown graphically for boys in Figure 1,[4] and and for girls in Figure 2. Except for certain differences in the older age groups, the principal characteristic of the relationship is clear, namely, growth in weight is more dependent on weight attained than on chronological age. In general the lines which describe the gains for the younger children fall closely together and tend to cross and recross each other without any consistent differentiation for the specific age classes. Certainly for boys from 6 to 11 years of age and for girls from 6 to 10 years of age weight already attained is a primary factor influencing gain during the following year. For both boys and girls, but to a lesser extent for boys, there is considerable fluctuation of the lines for the older age groups. Part of this fluctuation is due to the great variability of gains during this period of growth and represents only sampling variation. In spite of the sampling variation, however, the general pattern of the lines indicates that age is also an influential factor in growth of the older age groups. If the mean annual rates for boys in the 72-76 pound weight class are examined, for example, it is found that the average increments increase slightly in each successive age group. The same general finding is observable in the weight groups above this for boys and for a considerably wider range of weight groups for girls. Particular attention may be directed in this connection to the lines for the 12-13 year and 13-14 year old girls. These age groups represent a period characterized by the beginning of the menses for the majority of the girls and it is clear from the evidence presented here, supplemented by considerable collateral evidence, that other factors enter the growth process which are not present either before or after this period. The general finding of a direct and close relationship between attained weight and growth in weight is observable, however, for the 12-13 year group. The line representing the growth of girls in the 13-14 year group, on the other hand, remains relatively horizontal, indicating that for this group there is essentially no positive association between attained weight and growth.

It is not considered necessary at this time to discuss all of the details which appear in the tables. Certain points, however, may be mentioned. Thus, it is evident that growth in weight between 6 and 14 years of age is dependent both on age and on weight already attained. In boys, age apparently has little influence on average growth during the time that weight changes from 32 to 72 pounds. In girls, similarly, age has little effect on growth during the time that weight changes from 36 to 60 pounds. Increase in weight above these limiting values, in general, depends on both age and attained weight. A detailed analytical separation of the relative influence of these two factors, however, presents difficulties.[5] The importance of considering the implications of the general findings may, nevertheless, be indicated. Obviously, the usual method of expressing growth increments only in terms of gains for specific age groups may be quite unsatisfactory in many practical problems. If, for example, the growth of a group of

[4] In Figures 1, 2, 4 and 5, irregular values based on only a few cases are omitted from the graphs. No data, however, are omitted from the tables.

[5] It is considered sufficient at this time to state that attempts to derive mathematical expressions to represent the individual curves shown in Figures 1 and 2 and the composite curve in Figure 3 have not been successful.

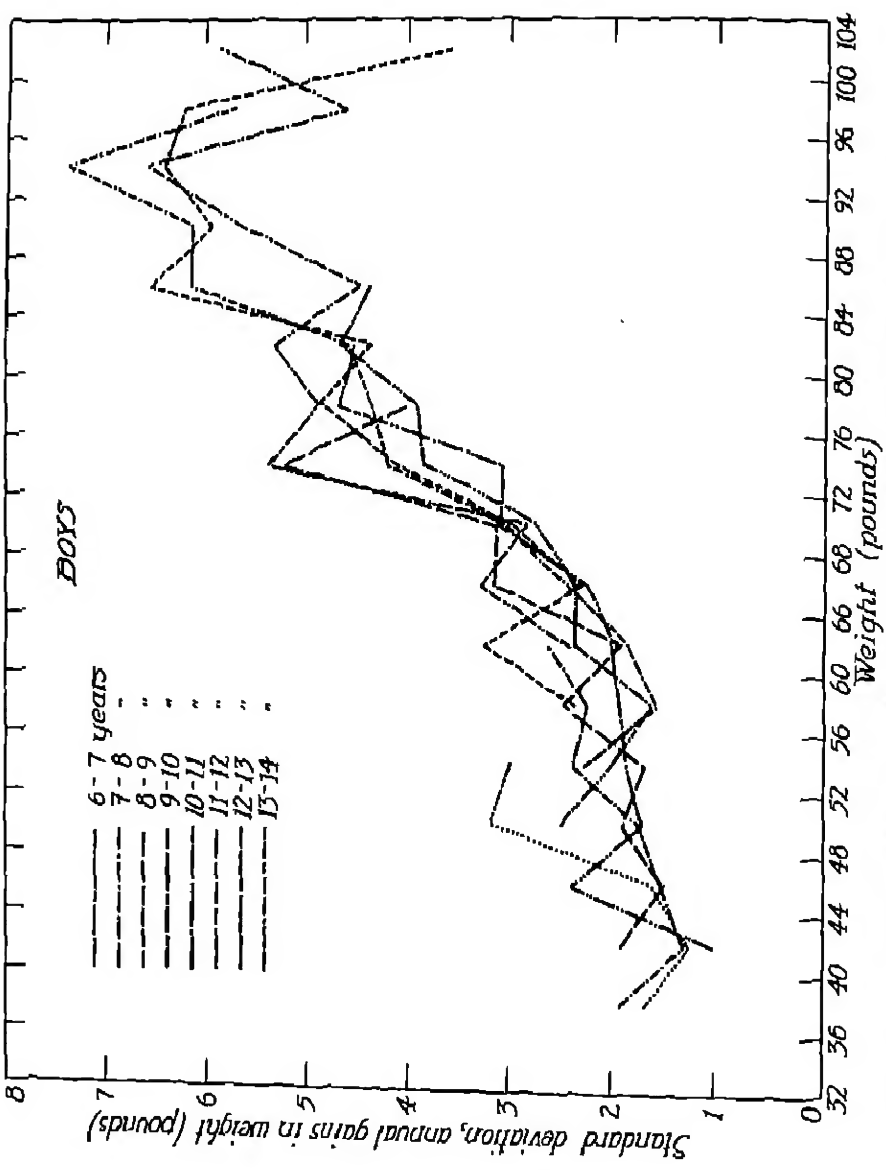

Figure 4. Standard deviations of annual gains in weight, specific for age and attained weight.

underweight or malnourished children is studied, quite erroneous conclusions may be reached if gains in weight are compared only with age specific increments. In the light of findings presented here it would appear to be necessary in many problems to take account of both age and attained weight. In some problems, however, it may be impractical to attempt to partial out both age and attained weight. Under such circumstances, the results of the present analyses indicate that if only one variable can be considered, more satisfactory results will be obtained by making the analyses specific for attained weight alone rather than for age alone. Thus it is shown that the gains of 10 year old girls vary from 6 to 14 pounds per year depending on whether the girls weigh 60 or 90 pounds at that age. The calculated average gain of 7.62 pounds per year for girls between their 10th and 11th year would furnish in many instances a highly unsatisfactory standard. In view of these circumstances, the average gains for children of the same weight but of different ages was calculated and reported in the tables. These data are presented graphically in Figure 3. According to this analysis, boys and girls gain in weight at essentially the same rate until both attain a weight of approximately 54 pounds. During the time that 30 pounds are added to their weights or until both attain a weight of approximately 85 pounds, girls grow more rapidly than boys of the same weight; both sexes grow at about the same rate after weights of 90 pounds are reached.

DISPERSING EFFECT OF GROWTH

Standard deviations of observed gains, as given in Tables 1 and 2, provide not only the usual measures of variability, but also quantitative measures of the tendency for individuals, alike with respect to weight at the beginning of the year, to become differentiated after a year of growth. The children included in the separate sex and age and weight sub-groups make up homogeneous classes of individuals; they are alike with respect to age and sex and, within four pounds, they weigh the same amount. At the end of a year of growth they have gained variable amounts in weight. Since the standard deviations are based on actual gains for homogeneous groups, they measure differences in growth and serve as indexes of the differentiating or dispersing effect of growth. Furthermore, since the grouping of the children into 4-pound sub-groups according to weight at the beginning of the year subdivides the population into many homogeneous classes, a study of these standard deviations may give a rather complete picture of the dynamics of the dispersing effect of growth during the whole of the growth period from the 6th to the 14th year of age. Although these indexes of the dynamics of growth may be utilized in a number of ways in the study of growth processes, the present paper will contain only a limited graphic analysis of the relationship between the dispersing index and age, sex and weight at the beginning of the year. Accordingly, Figures 4 and 5 show graphically the same analysis for the standard deviations of gains as was shown in Figures 1 and 2 for mean gains.

Viewing the data for boys (Figure 4), it will be noted that the lines representing standard deviations for the various age groups are superimposed upon each other to such an extent as to suggest that age is not a primary factor in the relationship. Between the weight range of 36 to approximately 90 pounds, it is reasonably clear that despite the irregular fluctuations which are due largely to sampling variations, the indexes of dispersion depend primarily on attained weight

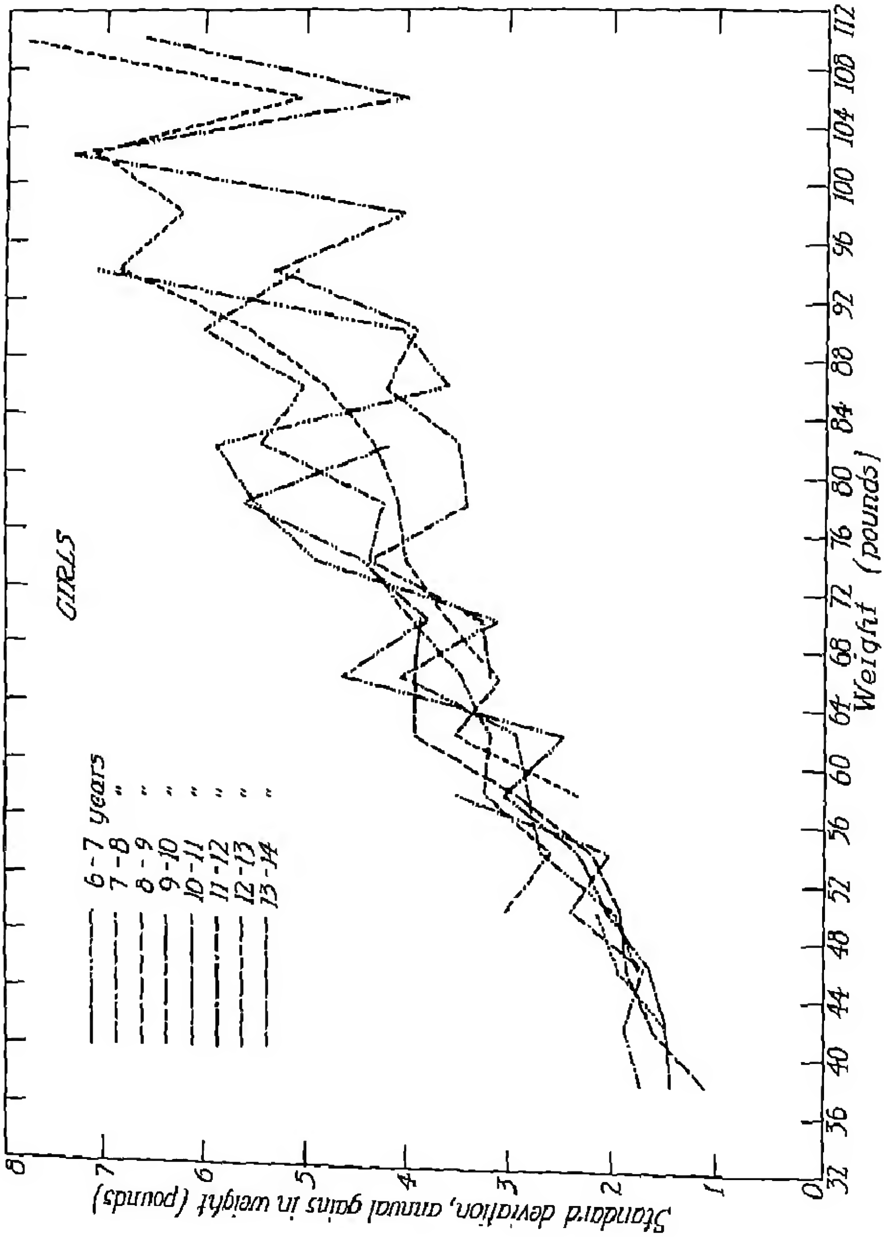

Figure 5. Standard deviations of annual gains in weight, specific for age and attained weight.

and that the dispersive effect of growth increases directly with increase in weight. The paucity of data for weights above 90 pounds does not permit a definite statement of the relationship.

An examination of the material for girls, presented in Figure 5, reveals essentially similar findings as those outlined for boys. The greater irregularity of the lines for the girls is indicative of the well known fact that growth of girls shows greater variation than growth of boys. It is probably permissible, however, to conclude that throughout the weight range from 36 to 86 pounds, the dispersive effect of growth increases regularly with increase in attained weight and that age is not an important determining factor in the relationship. Above the weight of 86 pounds the standard deviations for girls show great variation, probably because of the inadequacy of the data.

Since age appears to be only an incidental factor in determining the tendency for individuals of the same weight to differ after a year's growth, averages of the indexes of dispersion were calculated for each of the weight classes, disregarding age. The results of these calculations are shown in Figure 6. The averages of the dispersion index for girls follows very closely a straight line relationship throughout the range from 32 to 86 pounds. After the latter weight is attained, the line representing the relationship tends with considerable irregularity to become horizontal. The line, representing the changes of the index with increasing weight for boys, follows closely the line for girls until a weight of approximately 50 pounds is reached by both sexes. From this point until a weight of 72 pounds is attained, the line for boys is considerably lower than the line for girls, indicating that the dispersing effect of growth is less in boys than in girls of the same weight. Above weights of 72 pounds, the indexes for the two sexes are much alike, except that the dispersion is greater in boys in the weight range from 82 to 98 pounds.

In connection with the study of the indexes of dispersion, one additional point may be made, namely, that there would appear to be a marked positive association between the standard deviations and the means of the annual increments. Thus the curves shown in Figures 3 and 6 are very similar and led to the suggestion that changes in average gains in weight are accompanied by similar changes in variability of gains. An analysis of the correlation between means and standard deviations of increments, although showing clearly the presence of a positive association, does not reveal additional information of sufficient importance to warrant its inclusion in the paper.

SUMMARY

This paper represents the second part of a "longitudinal" study of growth. The first paper of the study contained an analysis of the relationship between height and growth in height of elementary school boys and girls. It was shown that growth in height is primarily dependent on chronological age between the sixth and tenth year in boys and the sixth and ninth year in girls. From the upper limits of these intervals of age, until the fourteenth year is reached, growth in height of both boys and girls shows a marked positive correlation with height already attained. It was shown, also, that there is a slight correlation between

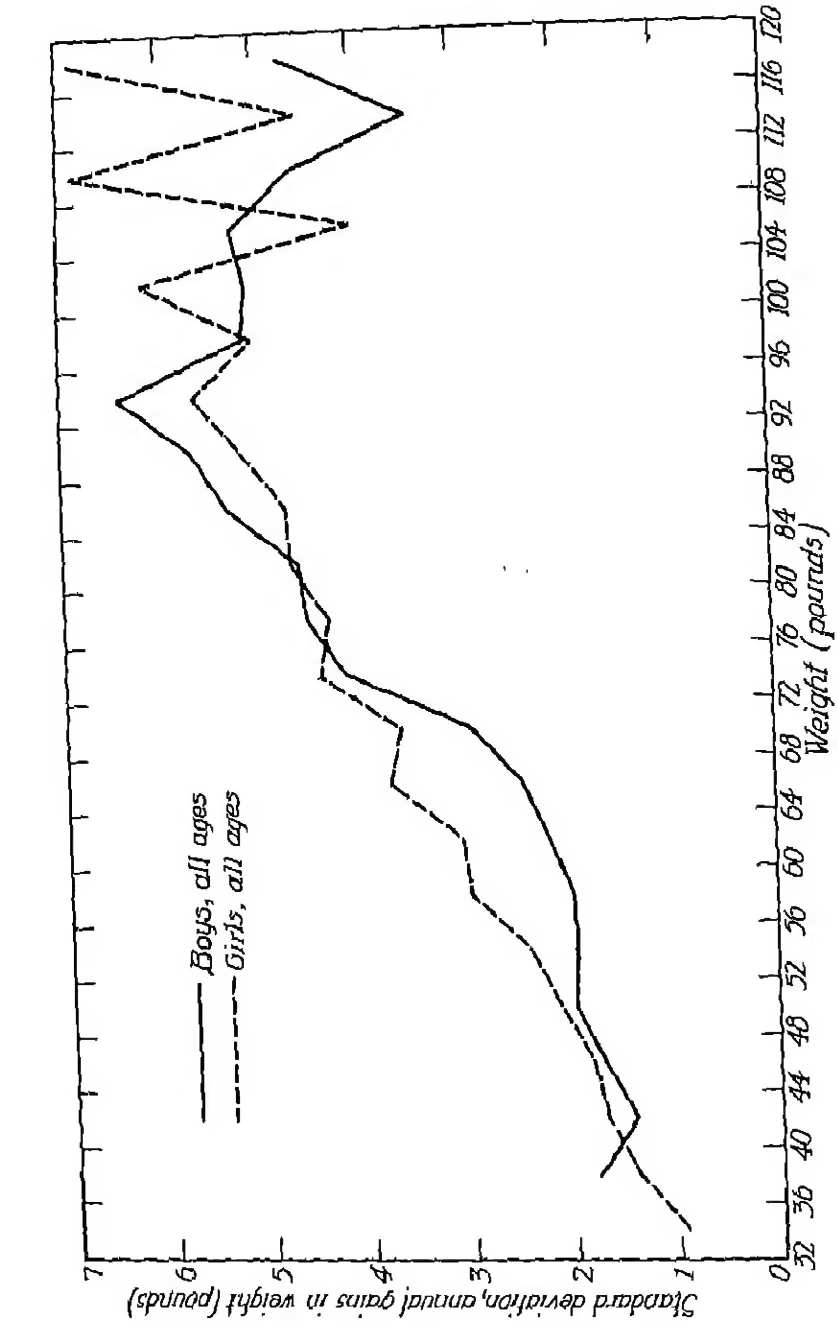

Figure 6. Standard deviations of annual gains in weight, specific for attained weight. All ages, 6 through 13 years.

the variability of growth in height and height itself.

The present paper consists of a similar analysis of the relationship between body weight already attained and growth in weight. The study is based on approximately 8,000 observed annual increments in body weight of elementary school boys and girls between the ages of six and fourteen years. A tabular and graphic analysis of these data in age and sex and weight specific classes show the following:

1. During the period of growth in which boys increase from 32 to 68 pounds in weight and girls increase from 32 to 60 pounds, the primary factor which influences growth is body weight already attained. When weight reaches the upper limits of these ranges, growth is influenced by attained chronological age, although attained weight is still the stronger factor in growth.

2. Standard deviations of distributions of annual increments, which in this study serve as indexes of a dynamic force termed the "dispersing effect of growth," are found to be strongly correlated with both attained weight and growth in weight.

Applications of the investigation are pointed out and it is indicated that in many practical studies on children it is necessary to consider attained weight in evaluating growth in weight.

AN EVALUATION OF VARIOUS INDICES OF LINGUISTIC DEVELOPMENT

JOHN E. ANDERSON [1]

In 1933 La Brant,[2] using as material compositions written by children in the fourth to the twelfth grades, published an interesting study of language development. She obtained an index of subordination by dividing the number of subordinate predicates by the total number of predicates in compositions of approximately 150 words. She found that the index of subordination increased with mental age and with chronological age, the curve for mental age rising from 8 1/2 years to 13 1/2 years and then falling off, while the curve for chronological age rose steadily from 8 1/2 years to 18 years. Although on the whole the girls showed a slightly higher index of subordination than the boys, at different age levels the relationship between the indices for the sexes varied. No evidence was found to support Jespersen's statement that subordination is more characteristic of males than of females.

Preliminary to a more detailed study of the development of written language in children the investigation reported in this paper was undertaken to solve several methodological questions. La Brant used a single composition and did not check the consistency of the Index of Subordination by comparing different compositions written by the same children. Although no children's compositions were immediately available for our study, it was found that in a course in composition in the General College of the University of Minnesota,[3] students were accustomed to write a preliminary draft of their compositions in notebooks which were then made available to the instructor before extensive criticism or correction was undertaken. As the choice of the theme was left to the individual these compositions dealt with a wide variety of subjects. From four different sets of compositions, sections of approximately 150 words (to the nearest complete sentence) were selected. These are hereafter designated as compositions 1, 2, 3, and 4, in the order in which they were written. From the first composition an additional section of approximately 150 words, coming immediately after the first 150 words, was selected. This section is called composition IA. For each individual, then, parts of four different compositions and an additional part of one composition were available. Compositions were obtained for a total of 111 students, of whom 56 were males and 55 females. Their ages ranged from 16 to 24 years with a mean of 19 years 4 months and a standard deviation of 17.9 months. In addition for all students percentiles in the Minnesota college aptitude test and in the Iowa English test were available. For 87 students high school ranking percentiles were also available. For this study percentiles were converted into sigma scores.

In addition to the index of subordination obtained by the La Brant method, the mean length of sentence for each individual and the standard deviation of sentence length from this mean were determined, together with a personal pronoun index

[1] From Institute of Child Welfare, University of Minnesota.

[2] La Brant, Lou L. A study of certain language developments of children in grades four to twelve, inclusive. Genetic Psychology Monographs 14:387-491. 1933.

[3] Appreciation of the interest and cooperation of Mr. Francis S. Appel, Instructor in English in the General College, is expressed.

obtained by dividing the number of personal pronouns in each passage by the total number of pronouns used in the selected sample of writing. Since second person pronouns were almost completely absent from the compositions, this index is virtually one which shows the ratio of first person pronouns to first and third person pronouns combined.

Table I presents the correlation coefficients[*] showing the interrelation of length of sentence in the different compositions. All coefficients are positive

TABLE I

INTERCORRELATIONS OF LENGTH OF SENTENCE IN SEVERAL COMPOSITIONS

	Composition 1	2	3	4
Composition 2	+.50			
Composition 3	+.24	+.20		
Composition 4	+.34	+.33	+.31	
Composition IA	+.35	+.16	+.36	+.32

but relatively low. The reliability coefficient determined from compositions I and IA is +.35 and the mean of the coefficients for the interrelations of all the compositions (exclusive of the coefficient between I and IA) is +.31. Since length of sentence is an objective measure obtained by counting, the obvious conclusion is that a passage 160 words in length is insufficient to obtain a characteristic or stable measure of sentence length.

Similar coefficients for the standard deviation of sentence length are presented in Table II. Again the coefficients are all positive and low. They are

TABLE II

INTERCORRELATIONS OF S.D. OF SENTENCE LENGTH FOR SEVERAL COMPOSITIONS

	Composition 1	2	3	4
Composition 2	+.12			
Composition 3	+.15	+.05		
Composition 4	+.18	+.27	+.07	
Composition IA	+.24	+.17	+.24	+.03

lower than those similarly obtained for length of sentence undoubtedly because of the intrinsic relation between the standard deviation and the mean. The reliability coefficient determined from compositions I and IA is +.24 and the mean of the coefficients for the relationships between the various compositions (exclusive

[*]All correlations are Pearsonian product-moments.

of the coefficient between I and IA) is +.14. Since this standard deviation is a function of sentence length it, too, is objective. A sample of 150 words is, then, too brief for obtaining a stable measure of variability in sentence length.

In Table III similar coefficients are presented for the index of subordination. The correlations are low and with one exception positive. The reliability coefficient for compositions I and IA is +.23. La Brant obtained a reliability coefficient of .61 (rank differences) or .63 (Pearsonian) for 21 samples of the published writing of psychologists. She, however, used 300-word samples in this portion of her study and points out that the finished product of experienced writers may not be comparable with that of children. The mean for the interrelations between the compositions, exclusive of the coefficient for I and IA, is +.07. These coefficients are surprisingly low and indicate that the index of subordination needs further study. Two factors are involved. The data on the length of sentence and the standard deviation of sentence length indicate that a sample of 150 words is inadequate for measures which are completely objective in their determination. Over and above this inadequacy of sample there is the further factor of a subjective element in the judgments upon which the index is based.

TABLE III

INTERCORRELATION OF SUBORDINATION INDEX FOR SEVERAL COMPOSITIONS

	Composition			
	1	2	3	4
Composition 2	+.11			
Composition 3	+.22	-.08		
Composition 4	+.05	+.05	+.04	
Composition IA	+.23	+.05	+.10	+.05

In our study the compositions were typed triple space on single sheets of paper. All coordinate predicates were underlined in black and all subordinate predicates in red. Wherever a question was raised as to the classification of a particular predicate, it was discussed with another person and an agreement reached as to the classification. As a check, composition I was retyped and given to a third person, who, after a general discussion of the criteria, marked the papers without further consultation. The correlation coefficient obtained for inter-person marking of the same passage is +.70, a figure sufficiently high to indicate inherent possibilities in the method. It is quite likely this coefficient could be substantially increased if a scale were prepared showing how doubtful constructions were to be classified.

In Table IV, coefficients for the pronoun index are presented. Although this index has much greater reliability for a single composition, as shown by the coefficient of +.61 between I and IA, the correlations between various samples of writing are extremely low. The mean coefficient for the interrelations of this index, exclusive of the coefficient for I and IA, is +.11.

TABLE IV

INTERCORRELATIONS OF PRONOUN INDEX FOR SEVERAL COMPOSITIONS

	Composition			
	1	2	3	4
Composition 2	.00			
Composition 3	+.02	+.09		
Composition 4	+.17	+.19	+.25	
Composition IA	+.61	+.05	+.04	+.20

In measuring a language product still another factor must be taken into account, namely the relationship between language and the situation or circumstances in which it is produced or the subject matter with which it is concerned. The high coefficient for compositions I and IA indicate that the pronoun index is fairly consistent within a single composition, but is worthless or of only slight value in predicting the index for another composition written at a different time and on a different subject. This factor undoubtedly operates in all the indices treated here. Language in its very nature is an extraordinarily flexible and adaptable instrument. To be sure, it is affected to some degree by personal standards of style and treatment. But even in a writer with a very consistent style there is undoubtedly a wide range of adaptation to situation and subject matter, with consequent variation.

THE INTERRELATION OF MEASURES

The interrelations of all the measures of language obtained, i.e. length of sentence, standard deviation of sentence length, index of subordination, and pronoun index were obtained for each composition. Since the resulting correlation tables are very similar, only the means are presented in Table V. Each coefficient in this table is the mean of the five coefficients obtained from compositions I, IA, 2, 3, and 4, respectively.

TABLE V

INTERRELATIONS OF LANGUAGE MEASURES

	Length of Sentence	S.D. of Sentence	Index of Subordination
S.D. Sentence	+.51		
Index of Subordination	+.49	+.30	
Pronoun Index	-.01	-.02	+.13

The mean of the coefficients for the relation between standard deviation of sentence and length of sentence, which is +.51, indicates that standard deviation of sentence length varies with the length of the sentence, as was to be expected. Sentence length varies more in the compositions in which long sentences are used than in those with shorter sentences.

The coefficient for the relationship between length of sentence and index of subordination, which is practically the same, +.49, shows that those who use longer sentences also tend to use more subordinate clauses. The relationship between standard deviation of sentence length and the index of subordination is consistently lower, being +.30 and indicates that while the use of subordinate clauses is a contributing factor in variations in sentence length, it is not the only factor. In general, sentences containing subordinate clauses seem to be longer than those containing coordinate clauses. Many students of style, including La Brant, have suggested that in the development of style there is a strong tendency to substitute subordination for coordination.

The personal pronoun index shows no relationship whatever to length of sentence or to the standard deviation of sentence length, the coefficients closely approaching zero. The small relationship (+.13) between the index of subordination and the pronoun index suggests a slight tendency in writers employing the first person to use more subordinate predicates than are used by those who write in the third person.

RELATIONSHIP OF INDICES TO OTHER FACTORS

Coefficients were calculated for the relationship between the various indices and chronological age, college aptitude scores, Iowa English scores and high school rank, for each of the indices and each of the compositions. The mean of all these coefficients are presented in Table VI.

TABLE VI

CORRELATIONS OF LANGUAGE MEASURES WITH OTHER MEASURES

	Length of Sentence	S.D. of Sentence	Index of Subordination	Pronoun Index
Age	+.06	+.02	-.04	-.04
College Aptitude	+.01	+.04	-.06	-.03
Iowa English	+.12	+.15	-.02	+.06
High School Rank	+.10	+.10	-.02	+.01

These approximate zero and indicate that there is no essential relationship between any of the indices used and the other measures available for the individuals in the very homogeneous group studied here. Length of sentence and standard deviation of sentence length seem to be slightly related to Iowa English scores and to high school rank.

SEX DIFFERENCES

Means were determined for each sex for language measures and each of the general measures used in this study and are presented in Table VII.

In general the girls show a consistent but slight tendency to use longer sentences, to vary their sentence length more, to use more subordinate clauses, and to use more personal pronouns. With but three exceptions out of the twenty

TABLE VII

COMPARISON OF SEXES

	Male	Female	Diff/σ Diff.
Length of Sentence	20.2	20.6	+.34
S. D. Sentence	8.2	8.7	+.73
Index of Subordination	49.3	50.2	+.32
Pronoun Index	47.7	53.6	+.90
Age	19.6	19.3	-.88
College Aptitude	41.3	43.6	+1.60
Iowa English	40.7	47.1	+4.30
High School Rank	44.8	49.4	+2.58

determinations on the individual compositions the differences all favor the girls. But it should be noted that the differences are of such slight significance when the Diff/σ diff. is calculated that they are probably meaningless. And when they are compared with the differences for the sampling data available for the groups shown in the last half of the table, it becomes clear that they are of no significance whatever.

Certainly there is no support here for the contention of some grammarians that linguistic skill as measured by the tendency to subordination is present in smaller amount in girls than in boys.

Although this study points out certain limitations of the index of subordination, when obtained on a short sample of written composition, in my opinion, it does not question the validity of the results obtained by La Brant so far as the chronological age and mental age relationships of the index are concerned. The subjects in this study are well beyond the period at which, according to her study, the developmental curve flattens out. In younger individuals the change in language with age may be so marked that it is apparent even when essentially unreliable measures are used.

The difficulties involved in the use of the index of subordination are apparent when we consider the results of both investigations in terms of the size of the indices obtained. La Brant used two groups of subjects. For her child subjects the highest median index, 36.25, was obtained for those 16 years old. On her group of twenty-one adult psychologists, for whom two passages from the Psychologies of 1930 were analyzed, the mean subordination index for the first sample was 45.3 and that for the second sample 46.5. The mean indices obtained on the basis of the first marking in our study lie between 46 and 51 for the various compositions. For composition IA the first marker obtained a mean subordination index of 50.20, whereas a second marker obtained a mean index of 38.13, which is in much closer agreement with what might have been expected from the La Brant results. Examination of the papers indicates that the chief difference lies in the interpretation of infinitives, many of which were construed by the first marker as subordinate predicates and were not so construed by the second. Although La Brant made a special study of infinitives, she does not make perfectly clear how they were handled in calculating the subordination index. Despite our attempt to

the La Brant technique closely, our interpretation of subordination was evidently less rigorous than hers. In the absence of a very detailed description of how specific clauses and phrases are to be rated, it is obvious that the level of the subordination index will be subject to variation depending upon the interpretations made by those using it. It should also be noted that our test of the index of subordination is the most rigorous that can be applied. Whereas La Brant used compositions written on the same topic, we used compositions as we found them regardless of topic. We were interested in the generality of the index in the hope that an easily applied and uniform measuring implement could be developed. Although our study indicates that this is probably out of the question, it leaves open a fertile field for the development of indices based on common subject matter, well categorized scales, and adequate samples from the standpoint of length of passage.

SUMMARY

1. A written passage approximately 150 words in length does not constitute an adequate sample for the study of written language. Measures that can be determined with maximum objectivity, such as length of sentence and standard deviation of sentence, show low positive relationships with those obtained on similar passages taken from other compositions, while indices in which a subjective element enters show even lower relationships.

2. *The results suggest that within the language product of a single individual* indices of written language vary with the situations in which language is used and with the subject matter.

3. The indices here considered show some interrelation with each other. Length of sentence, standard deviation of sentence length, and the index of subordination are positively related. The pronoun index is not related to the length of sentence or to standard deviation in sentence length but is slightly related to the index of subordination.

4. For the highly selected group of subjects used in this study, none of the indices show significant relationship to age, college aptitude, Iowa English Scores, or high school rank.

5. No significant relationship between sex and the linguistic indices studied was found.

MEAN SENTENCE LENGTH COMPARED WITH LONG AND SHORT SENTENCES AS A RELIABLE MEASURE OF LANGUAGE DEVELOPMENT

EDITH A. DAVIS [1]

Although the mean length of sentence is a very valuable index of language development, it does not give due weight to sentences which lie at the extremes of the distribution. In analyzing 21,800 remarks of 436 children[2] the writer found that nearly 20 per cent were of only one word, while on the other hand there were many sentences which reached 20, 30, and even 50 words. These very long and very short remarks are here compared with mean sentence length from the standpoint of reliability and the portrayal of group differences in development.

At the upper end of the scale the sentences considered were each child's longest sentence and the mean of each child's five longest sentences. In this way all subjects were equally represented in the analysis, and group differences which might have been misinterpreted if long sentences had been arbitrarily defined as those exceeding 8, 10, or 12 words in length became meaningful. Although such a method might give a clearer picture of the characteristics of long sentences, the consequent elimination of many of the subjects (because no sentences over the arbitrary limit were present in their records) would have nullified the careful selection of cases on a cross-section basis.

Since 10 per cent of each child's remarks were considered long sentences for that child, the variability in the length of the long sentences studied was necessarily great. The range in longest sentences was from 2 words for a kindergarten child who could hardly talk at all to 56 words for a fourth grade girl. The mean of the 5 longest remarks ranged from 1.4 to 38.4 words. The mean and the reliability of the mean of long sentences at each age level studied, as well as that for the mean of 50 remarks, will be found in Table I.

TABLE I

INCREASE IN SENTENCE LENGTH WHEN MEASURED BY THE LONGEST, THE MEAN OF 5 LONGEST, AND THE MEAN OF 50 REMARKS

Subjects		Longest Sentence			Mean of 5 Longest			Mean of 50 Remarks		
Age in years	No. of Cases	Mean no. of words	S.D.	S.D.m	Mean no. of words	S.D.	S.D.m	Mean no. of words	S.D.	S.D.m
5 1/2	248	13.5	5.79	.37	10.3	3.52	.22	4.57	1.41	.09
6 1/2	63	18.2	5.84	.73	12.2	3.36	.42	5.28	1.37	.17
9 1/2	125	20.2	8.79	.79	15.6	5.48	.49	6.55	2.30	.20

[1] From Institute of Child Welfare, University of Minnesota.

[2] Davis, Edith A. The Development of Linguistic Skill in Twins, Singletons, with Siblings and Only Children. University of Minnesota, Institute of Child Welfare Monograph Series Number XIV. In Press.

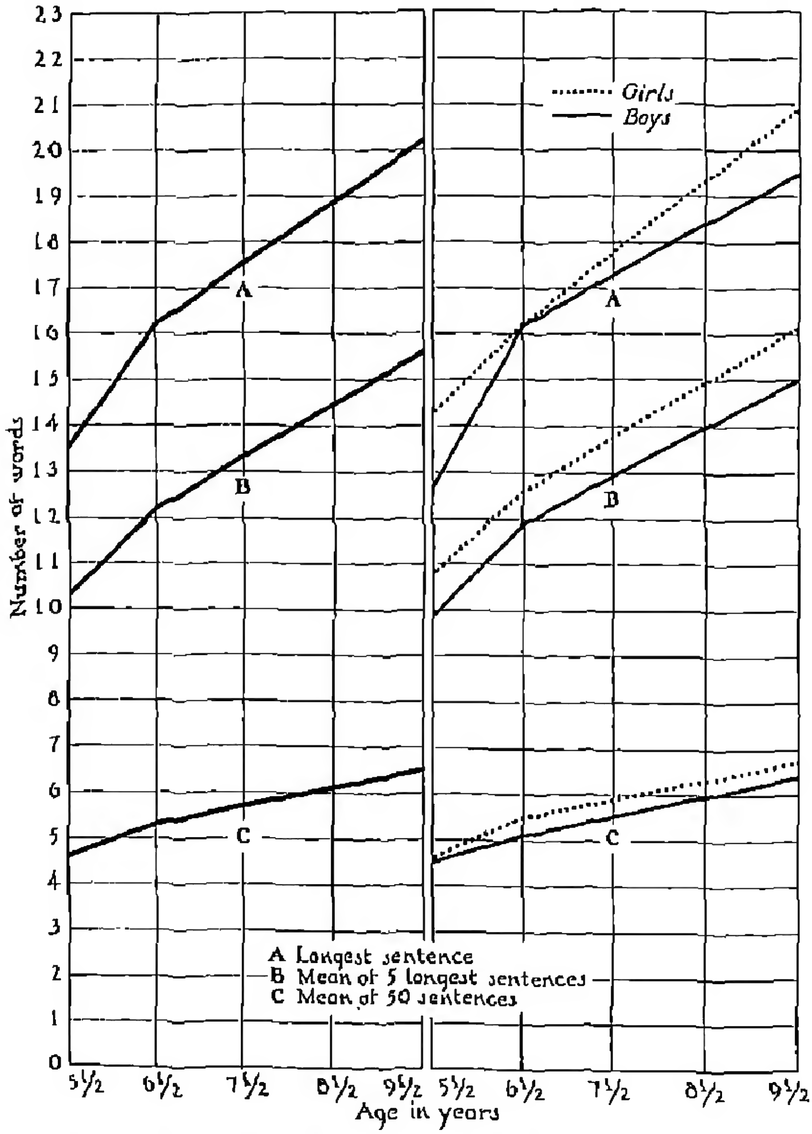

Figure 1. Increase with age in length of longest, the mean of 5 longest, and the mean of 50 remarks.

Figure 2. Increase in length of longest, mean of 5 longest, and mean of 50 remarks for boys and for girls.

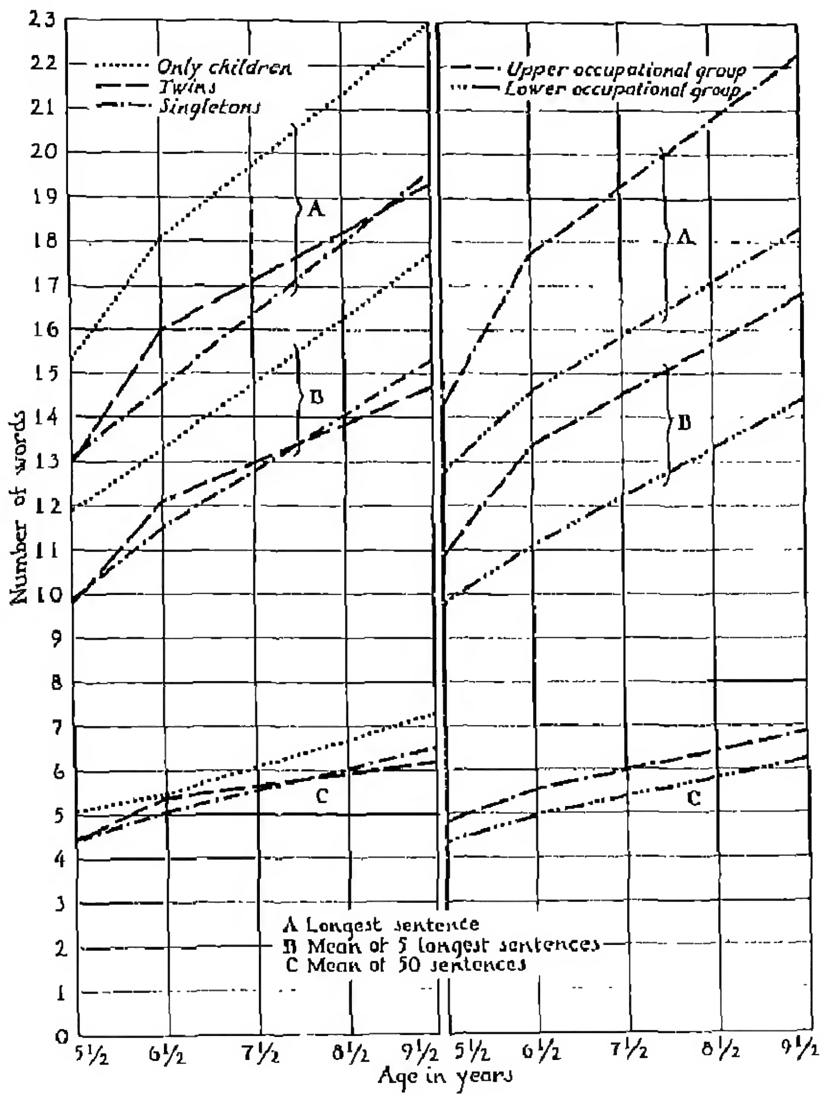

Figure 3. Increase in length of longest, mean of 5 longest, and mean of 50 remarks for twins, singletons, and only children.

Figure 4. Increase in length of longest, mean of 5 longest, and mean of 50 remarks for children from upper and lower occupational groupings.

Although all the measures show development from year to year Figure 1 indicates that the increase is more noticeable in long sentences than in the mean of 50 remarks.

The superiority in mean sentence length of girls, only children, and children from the upper occupational groupings, which was found in the major study become even more clear when long sentences are the method of measurement. These findings are presented in Figures 2, 3, and 4. Similarly, the difference in mean sentence length between kindergarten children with perfect and faulty articulation reported in the major study was found to exist when the groups were compared for the longest and mean of 5 longest sentences, and for the number of one word remarks. Articulatory difficulties, usually of the infantile type, were present in 88 of the 248 subjects at the 5 1/2 year age level. The mean sentence length for the perfect group was 4.85 words, and for the faulty group 4.00 words, with a critical ratio between groups (D/S.D. diff.) of 4.39. Table II shows the consistency of this difference when the sampling includes only very long or very short remarks.

TABLE II

COMPARISON OF VERY LONG AND VERY SHORT REMARKS OF CHILDREN AT 5 1/2 YEARS ON THE BASIS OF ARTICULATION

Group	Number of cases	Mean length longest	Mean length of 5 longest	Number of one-word remarks
Faulty	88	11.7	9.06	11.83
Perfect	160	14.5	11.03	9.70

At each age there is a slight positive relationship between length of sentence and intelligence. This correlation, calculated by the Pearson product-moment method, is very constant whether the unit of measurement is the longest, the mean of 5 longest, or the mean of 50 remarks. Table III gives the exact relationship.

TABLE III

CORRELATION BETWEEN IQ AND SENTENCE LENGTH

Age in years	Longest sentence	Mean of 5 longest	Mean of 50
5 1/2	.20	.24	.48
6 1/2	.36	.22	.21
9 1/2	.20	.19	.20

The measure of short sentences used was the number of single word remarks for each child. The relationship between number of single word responses and IQ is slightly negative, and the mean number of such responses decreases somewhat with age. These findings are summarized in Table IV.

TABLE IV

MEAN NUMBER OF SINGLE WORD RESPONSES

Age in years	Mean	S.D.	S.D.m	Correlation with IQ
5 1/2	10.90	8.85	.56	-.19
6 1/2	9.30	7.04	.89	-.03
9 1/2	8.34	2.94	.28	-.36

The critical ratio (D/S.D. diff.) between the number of such responses at 5 1/2 and at 9 1/2 years is 4.06, which satisfies the criterion usually set up for statistical reliability.

Throughout the analysis of the data the writer was impressed by the consistency of sentence pattern for individual children. That is, a child whose mean length of sentence was long tended to use many long sentences, rather than a few long ones and the rest short. Conversely, a very long sentence was seldom found in the record of a child whose mean length of sentence was short. Statistical verification of this impression was obtained by the calculation of reliability coefficients. Since a child's remarks tended to increase in length as he became more at ease in the experimental situation, the data, consisting of 50 remarks for each child, were divided by the odd-even method, rather than by taking first and second halves. The longest sentence, the mean of the 5 longest sentences, the mean of all 25 sentences, and the number of one word remarks in the odd section were correlated, using the Pearson product-moment formula, with the corresponding measures in the even section. Since this method takes account of only one-half the actual data, the coefficients were corrected by using the Spearman-Brown prophecy formula. The findings are summarized in Table V.

TABLE V

RELIABILITY COEFFICIENTS OF FOUR MEASURES OF LANGUAGE DEVELOPMENT

Age in years	Longest	Mean of 5 longest	Mean of 25	Number of one-word remarks
5 1/2	.59	.84	.91	.94
6 1/2	.73	.84	.87	.79
9 1/2	.86	.92	.95	.87

It appears that the longest sentence is least reliable and the mean of 25 sentences is most reliable at each age. In general, the language of the child at 9 1/2 years seems to have become somewhat more uniform in pattern than is the case with younger children. For certain purposes the number of one-word remarks in a given sample of spoken language would seem to be a satisfactory and easily calculated measure of language development. The mean of 5 longest remarks shows development so clearly and is so nearly equal in reliability to the mean of the entire sample, that it should be seriously considered as a measure in future

studies of language.

Among the subjects at the 5 1/2 year age level were 38 pairs of like-sex twins. Since the similarity between members of such pairs in many mental traits is well established, a comparison was made of the correlation between members of twin pairs with that between the two halves of the data for the same individuals, using the method for correlating interchangeable variables devised by Goodenough.[1] For all the measures under consideration there is an appreciable relationship between twin pairs, but the reliability of the two halves of the data is much greater, as may be seen in Table VI.

TABLE VI

COMPARISON OF THE RESEMBLANCE BETWEEN LIKE-SEX TWINS AT 5 1/2 YEARS WITH THE ODD-EVEN RELIABILITY OF THE DATA FOR MEMBERS OF THE PAIRS

Groups Compared	Longest sentence	Mean of 5 longest	Mean of all remarks	Number of one-word remarks
Members of Pairs	.35	.42	.51	.66
Halves of Data	.44	.84	.88	.98
Halves of Data[2]	.61	.91	.94	.99

The same comparison was made using the difference between means for members of pairs and for the two halves of the data. In this case 12 sets of unlike-sex twins were included, since inspection of their records had indicated that the same trend is present. The findings are presented in Table VII.

TABLE VII

COMPARISON OF THE MEAN DIFFERENCE BETWEEN MEMBERS OF TWIN PAIRS AND THE MEAN DIFFERENCE BETWEEN THE HALVES OF THE DATA FOR THE INDIVIDUALS MAKING UP SUCH PAIRS

Mean difference between	Longest sentence	Mean of 5 longest	Mean of 50 remarks	Number of one-word remarks
Members of pairs	4.21	2.56	0.88	5.29
Halves of data	3.31	1.88	0.79	1.86
Critical ratio	1.65	1.07	1.07	9.53

In the mean length of all remarks, members of pairs are nearly as much alike as are the two halves of the data. The greatest difference is in the number of one word remarks, which definitely implies that in the use of such remarks members of pairs are very different, while the individual is very consistent.

[1] Goodenough, F. L., and Anderson, J. E. Experimental Child Study. The Century Company, New York, 1931, pp. 239-243.

[2] Corrected by Spearman-Brown prophecy formula.

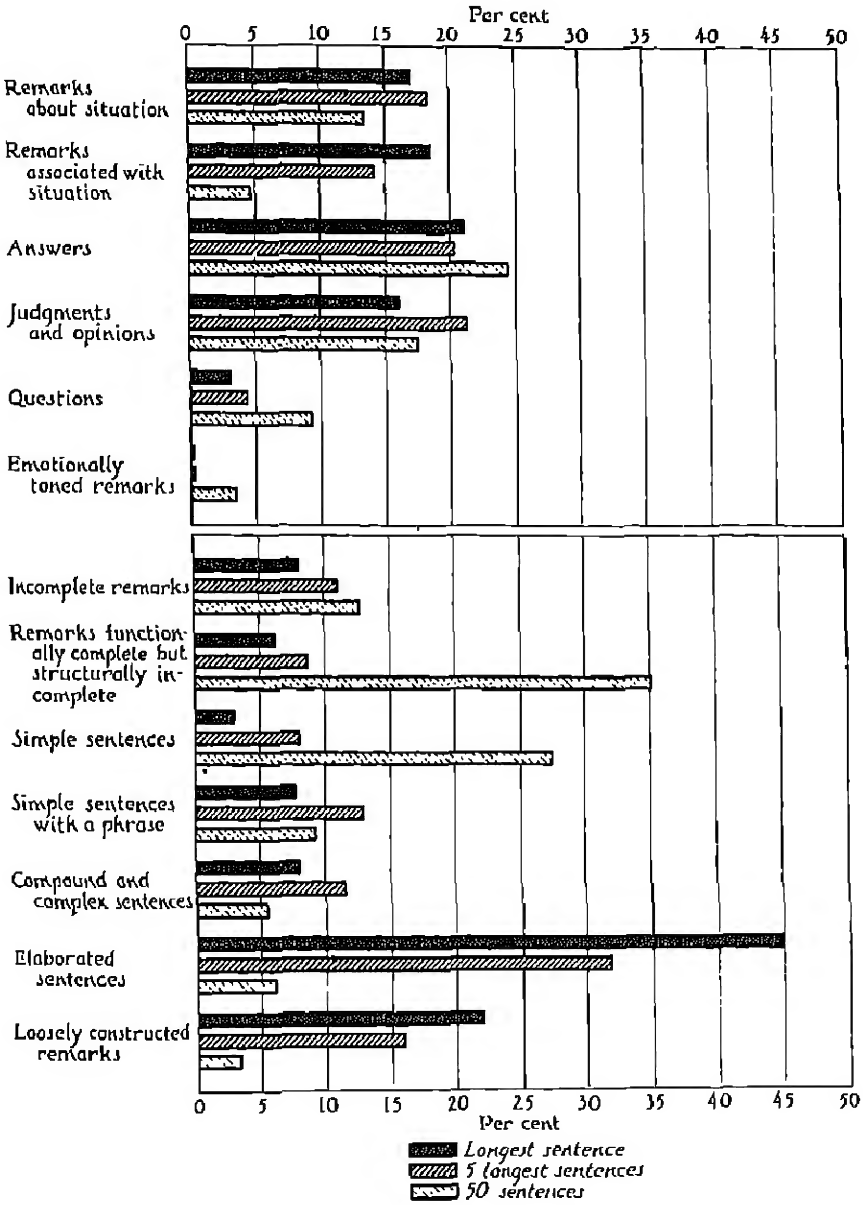

Figure 5. Comparisons of longest, mean of 5 longest, and mean of 50 remarks by functional and structural categories.

Long sentences present certain well-defined characteristics of function and structure which indicate that such sentences do not give an accurate picture of the importance in children's language of certain forms. A large number of functional categories were distinguished in the major study, many of which proved to be of minor importance. Some of these are scarcely represented among the long sentences, and it is only in the larger categories that trends can be considered at all conclusive.

Questions tend to be short. Answers at 9 1/2 years tend to be uniform in length, but at 5 1/2 and 6 1/2 they tend to be short. The greater length at 9 1/2 years may result from school experience, since by the time they reach the fourth grade children have received much training in recitation, and are expected to use complete sentences in replying to the teacher. Remarks about the immediate situation and associated with the situation tend to be long. Opinions and judgments tend to be long at 5 1/2 years, but thereafter they tend to be short. Emotionally toned remarks tend to be very short. These trends are shown in upper half of Figure 5.

In the major study the scheme of classification for sentence structure was roughly as follows:

1. Incomplete remarks.
2. Remarks functionally complete but structurally incomplete. (Many answers, some questions, and many emotionally toned remarks were of this type.)
3. Simple sentences without a phrase.
4. Simple sentences with a phrase.
5. Compound and complex sentences.
6. Elaborated sentences (with two phrases, two clauses, or a phrase and a clause.)
7. Loosely constructed sentences. (These were differentiated because a child frequently corrected himself or interrupted his line of thought midway in a sentence.)

One would expect that compound and complex, elaborated, and loosely constructed sentences would tend to be long and that the others would tend to be short. The lower half of Figure 5 shows that this is strikingly true. However, children do not use a high percentage of highly compounded sentences which simply consist of a number of simple sentences strung together with <u>and</u>, <u>but</u> and <u>or</u>. Table VIII shows that long sentences express much more complicated shades of meaning than do short sentences. Subordinate clauses and infinitives are not only absolutely much more frequent in the long sentences, but also when their occurrence is related to the total number of words making up such sentences. This is even more clearly shown in Table IX by comparing the mean number of subordinate clauses and infinitives in the 5 longest sentences with those in the other 45 sentences.

Further differences between long and short sentences may be distinguished by the type of subordinate clause most frequently used. Table X shows that of all the subordinate clauses used by all the subjects, 39 per cent were found in the 5

TABLE VIII

MEAN NUMBER OF SUBORDINATE CLAUSES AND INFINITIVES PER 100 SENTENCES AND PER 1000 WORDS IN LONGEST, 5 LONGEST, AND 50 SENTENCES

Use of	Age of Subjects	Number of Cases	Mean per 100 Sentences Longest	5 Longest	50	Mean per 1000 Words Longest	5 Longest	50
Subordinate	5 1/2	248	54	34	8	40	33	19
Clauses	6 1/2	63	43	42	11	26	35	22
	9 1/2	125	102	70	18	51	45	28
Infinitives	5 1/2	248	12	12	3	9	11	7
	6 1/2	63	11	9	4	7	8	8
	9 1/2	125	42	28	10	21	18	15

TABLE IX

MEAN NUMBER OF SUBORDINATE CLAUSES AND INFINITIVES PER CHILD IN THE 5 LONGEST AND IN THE 45 OTHER REMARKS

Age in years	Mean number clauses 5 longest	45 other	Mean number infinitives 5 longest	45 other
5 1/2	1.7	2.6	0.58	0.98
6 1/2	2.1	3.6	0.48	1.57
9 1/2	3.5	5.6	1.40	3.39
All	2.3	3.6	0.81	1.76

longest sentences, and 61 per cent in the other 45 sentences. There was a preponderance of noun and adjectival clauses in the 45 sentences, but of adverbial clauses in the long sentences.

TABLE X

PER CENT OF EACH TYPE OF SUBORDINATE CLAUSE FOUND IN 5 LONGEST AND IN 45 OTHER SENTENCES

Per cent in	Noun	Adjectival	Adverbial	All
5 Longest	31.8	37.5	58.8	39.1
45 Others	68.2	62.4	41.2	60.8
Total	100.0	99.9	100.0	99.9

There is some evidence in the literature that indicates that in adult usage the distribution of noun, adjectival, and adverbial clauses is approximately equal. Young children use a high percentage of noun clauses and few adverbial clauses, but as they develop these proportions are reversed, leaving the percentage of adjectival clauses practically unchanged. Table XI shows that the proportion of adjectival clauses is nearly the same in short as in long sentences, but

TABLE XI

PERCENTAGE DISTRIBUTION OF SUBORDINATE CLAUSES IN 5 LONGEST AND 45 OTHER SENTENCES BY TYPE OF CLAUSE

Type of Sentence	Noun		Adjectival		Adverbial		All	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
5 longest	333	33.2	190	18.9	480	47.8	1003	99.9
45 others	714	45.8	316	20.3	529	33.9	1559	100.0

there are more noun clauses and fewer adverbial clauses in short sentences.

Analysis of all the adverbial clauses by type indicates that clauses of time, condition, result, and concession are relatively more frequent in the long sentences, but that the reverse is true of clauses of cause, manner, purpose and place. Clauses of place and concession were so infrequent that only tentative conclusions may be drawn on the basis of the data at hand, but these findings do suggest that long sentences alone would not give a true picture of the relative importance in a child's language of the various types of subordinate clause.

Grammatical errors are more frequent per remark in long sentences, but when the greater length of the long sentences is taken into account the error ratio is found to be slightly less for long sentences. These findings are given in Table XII and XIII.

TABLE XII

MEAN NUMBER OF ERRORS PER 100 SENTENCES AND PER 1000 WORDS IN LONGEST, 5 LONGEST, AND IN 50 SENTENCES

Age in years	Mean per 100 Sentences			Mean per 1000 Words		
	Longest	5 longest	50	Longest	5 longest	50
5 1/2	31	28	14	23	27	32
6 1/2	33	26	13	26	21	24
9 1/2	41	29	14	20	18	22

TABLE XIII

MEAN NUMBER OF ERRORS PER CHILD IN 5 LONGEST AND IN 45 OTHER REMARKS

Age in Years	5 Longest	45 Others
5 1/2	1.39	5.84
6 1/2	1.30	5.14
9 1/2	1.44	5.77
All	1.39	5.72

When a child uses a long sentence he seems to be putting forth his very best effort to express a complicated idea. For this reason long sentences should constitute a valuable measure of maximum ability in the use of language.

SUMMARY

1. Group differences are constant, whether the longest sentence, the mean of 6 longest sentences, or the mean of 50 remarks is employed as the measure of language development.

2. There is a slight positive relationship between length of remark and IQ. The correlation is somewhat greater at 5 1/2 years for the mean of 50 remarks; at 6 1/2 years there is a greater relationship between the longest sentence and IQ; and at 9 1/2 years the relationship is constant for all three measures.

3. The number of one word remarks decreases somewhat with age.

4. There is a slight negative relationship between the number of one word remarks and IQ.

5. Long sentences clearly show development from year to year and are very evenly distributed through the sample of 50 sentences on the basis of odd-even division of the data.

6. All these measures are highly reliable, and the reliability increases with age.

7. The reliability between odd and even remarks of individual members is much greater than the resemblance between like-sex twin pairs.

8. There is reason to believe that the mean of the 6 longest remarks will prove for most purposes fully as satisfactory a measure of language development as the mean of 50 remarks.

9. The use of one word remarks is very consistent for individual children, but this characteristic probably depends upon other factors than mental development.

10. Long sentences tend to be highly complex, although sometimes rather loosely constructed, and slightly more accurate than are short sentences.

11. In long sentences a large percentage of adverbial clauses are used, and a small percentage of noun clauses. In long sentences adverbial clauses of time and condition are especially important, but in short sentences there is a higher percentage of clauses of manner and cause.

12. The child tends to use long sentences in discussing the situation which engages his attention, or some topic which he associates with the situation.

CORRELATIONS OF PERFORMANCE TESTS WITH OTHER ABILITIES AND TRAITS IN GRADE I

FRANK T. WILSON AND CECILE WHITE FLEMMING[1]

During the school year 1933-34 a variety of tests was given to twenty-five children in Grade I of the Horace Mann School, Teachers College. These included tests of "reading readiness"; many of the Gates Reading Diagnosis tests; some reading achievement tests; mental ability tests, such as the Stanford Revision of the Binet-Simon tests and various performance tests; certain psychological tests, as of perception and perseveration; and several measures of psycho-physical and personality traits and of home background. The purpose of the study was to examine any possible relationships that might exist between measurable traits and abilities, and early progress in the mechanics of reading.

The children of the group came from well-to-do homes. A large percentage of the parents were professional people. The following averages for these pupils were found:

Chronological Age	6.31
Mental Age	7.61
Intelligence Quotient	120.6

Nearly every test and measurement was given or made individually, under carefully controlled conditions, and by reliable persons accustomed to administering tests to young children. The cooperation of the pupils was almost invariably excellent. It is believed for these reasons that errors of examination were unusually low.

This report presents correlations of a battery of "Performance Tests" with about one hundred other measures and appraisals used in the original study. The following performance tests were used:

1 - The Seguin-Witmer-Sylvester Form Board
  Score: Average time, 3 trials
2 - Healy-Fernald, Mare & Foal Test
  Score: (a) Time (b) Errors
3 - Pintner-Patterson, Manikin Test
  Score: Time
4 - Pintner-Patterson, Ship Test
  Score: Standard weighted correct responses
5 - Healy, Picture Completion II
  Score: Standard weighted correct responses

[1] This report presents a minor phase of a study of Reading Readiness and Reading Progress in the Primary Grades of the Horace Mann School, Teachers College, New York, 1933-36. This study has been made possible by the cooperation of Miss Agnes Burke, Teacher of Grade I and other teachers of Kindergarten and Primary Grades. It has been made under the supervision of Doctor Cecile White Flemming, Director of Pupil Individual Development and Guidance, and of Doctor Rollo G. Reynolds, Principal. Prepared by Frank T. Wilson with the assistance of the U.S. Works Progress Administration, New York City, project Number 65-97-295, sub-project 25.

The tests were given according to standardized directions.

The data of the study are in terms of correlations obtained by the rank order method. To secure the rank orders measures and appraisals were reduced to numerical scores. Owing to lack of facilities it was not feasible to make all the computations that were possible in the original study. A "finder" device was used to select for computation the correlations which seemed to promise significance. It is believed that through the use of this device, although it was not altogether accurate, all the high and fairly high correlations were found. The correlations omitted were probably below .50, and most of them probably nearer zero than .50. The P. E. of rho's when N=25, range from ± .0237 for .90 to ±.1335 for .10.

The validity of many of the measures and appraisals is uncertain. Few correlations of seemingly unusual size were obtained, however, and few which were inconsistent with other correlations for the same kind of traits and abilities as found in the complete data of the original study. The opinions of the teacher, of the school psychologist, and of other qualified persons who have studied the figures, are that the results have quite high validity.

II. FINDINGS

Table 1 gives the intercorrelations of the performance tests.

TABLE 1

INTERCORRELATIONS OF PERFORMANCE TESTS

	Mare & Foal Time	Mare & Foal Errors	Manikin	Ship	Healy Picture II
Seguin	.31	-.12	.42	.24	.49
Mare & Foal, Time		.70	.27	.09	.40
" " Errors			.05	.19	.25
Manikin				.08	.56
Ship					.45
Average .298					

Mare and Foal time and errors correlated quite high, .70; manikin and Healy II correlated fairly high, .56. The other intercorrelations ranged from .49 to -.12. The low reliability of the measurements, due to the small number of cases and the immaturity of the subjects, may account, in part, for the low correlations. However, the high correlation of Mare and Foal time and error scores, in contrast with the much less significant correlations of Healy II scores with Seguin, Mare and Foal time, manikin, and ship scores, seems to indicate that the tests measure abilities of varied nature as far as those six and seven year old children were concerned.

Table 2 gives the correlations of the performance tests with mental age and

TABLE 2

CORRELATIONS OF PERFORMANCE TESTS WITH BINET M.A. AND I.Q.

	M. A.	I. Q.
Seguin	.32	.10
Mare & Foal, Time	.47	.54
Mare & Foal, Errors	.21	.44
Manikin	.21	.04
Ship	.45	.37
Healy II	.32	.11
Average	.33	.27

intelligence quotient of the Stanford Revision of the Binet-Simon test.

The range of these correlations, from .04 to .54, may be indicative that the performance tests measure abilities which vary from little or no similarity to considerable similarity to the abilities measured by the Binet test.

Table 3 gives correlations of the performance tests with certain other measures.

TABLE 3

CORRELATIONS OF PERFORMANCE TESTS AND CERTAIN OTHER MEASURES

Other Measures*

	Information	C. A.	Perseveration	Perception	Tapping	Grip	Vocabulary	Averages
Seguin	.44	.24	-.03	.36	.16	.42	-.11	.21
Mare & Foal, Time	--	-.07	.22	.18	-.07	.01	.04	.05
" " Errors	--	-.24	.27	-.08	-.01	-.16	.00	-.04
Manikin	.39	.24	.42	.35	--	.40	--	.36
Ship	--	.15	-.03	.09	--	—	--	.07
Healy II	.41	.40	.14	.33	--	--	.22	.30
Averages	.41	.12	.17	.21	.03	.17	.04	

*The tests used for the other measures were:

Information: Metropolitan Reading Readiness Tests, Subtest 6

Perseveration: Elkins-Maller Attention Test, Parts II and III

Perception: Exposure of 32 cards, original

Tapping: Whipple-Healy

Grip:	Dynamometer, average right and left hands
Vocabulary:	Combined scores on Lists 1 and 2 Binet, 20 Action-Agent words, 25 words from the Iowa Kindergarten Vocabulary Tests.

These coefficients are not high and the variability is large. The information test gave the most consistently high correlations with the battery, averaging .41 for three correlations. The manikin test gave the most consistently high correlations with the seven measures, averaging .36 for five correlations.

Tables 4-8 give the computed correlations of the performance tests with groupings of tests and appraisals of reading, letter abilities, mental abilities, psycho-physical and personality traits.

TABLE 4

CORRELATIONS OF PERFORMANCE TESTS WITH MEASURES OF READING ABILITY

	Seguin	Mare & Foal Time	Mare & Foal Errors	Manikin	Ship	Healy II	Average
Gates Primary Reading Tests, Type 2, Sentence Reading, March		.57				.52	.55
Gates Primary Reading Tests, Type 3, Paragraph Reading, March		.45			.38	.50	.44
Hildreth, First Grade Reading Analysis Test, Matching Words		.38					.38
Hildreth, First Grade Reading Analysis Test, Matching words and phrases in sentences		.48				.43	.46
Teacher's Ranking in Reading, November prediction	.21	.43	.00	.17	.25	.44	.25
Teacher's Ranking in Reading, May ability	.19	.42	.03	.19	.18	.47	.25
Gates Primary Reading Tests, Type 1, Word Recognition, May	.10	.57	.26				.31
Gates Primary Reading Tests, Type 2, Sentence Reading, May	.09	.41	.00			.44	.24
Gates Primary Reading Tests, Type 3, Paragraph Reading, May	.10	.52	.18	.15	.09	.36	.23
Averages	.14	.47	.094	.17	.23	.45	.346

Table 4 shows the correlations of the performance tests with reading tests. These results have particular significance because the 91 intercorrelations of the 14 reading measures of the original study averaged .73. The Mare and Foal time test and the Healy Picture Completion II gave the highest averages, .47 and .45, as shown in Table 4. The variability of the separate correlations of these

two tests with the reading tests was not very great, ranging from .38 to .57 for the Mare & Foal, time, and from .36 to .52 for the Healy. All the other computed correlations of the table were low and, considering the large probable errors, indicate little, if any, significant relationship between the reading and the mental or other abilities involved in those performance tests. Even in regard to the Mare and Foal and the Healy tests it seems that the abilities involved were not closely related to the reading abilities tested.

TABLE 5

CORRELATIONS OF PERFORMANCE TESTS WITH MEASURES OF ABILITY WITH LETTERS

	Seguin	Mare & Foal Time	Mare & Foal Errors	Mani-kin	Ship	Healy II	Aver-age
Van Wagenan Reading Readiness Test, Word Discrimination	.32					.33	.33
*G. R. D. T. VIII, 2, Word Recognition - Visual Presentation	-.08	.40					.16
*G. R. D. T. VIII, 3, Word Recognition - Auditory Presentation	.13	.32					.23
*G. R. D. T. IX, 1-7, Giving Phonic Combinations	.16	.19					.18
*G. R. D. T. IX, 9, Giving Letter Sounds	.31	.39					.35
*G. R. D. T. X, 1, Blend Sounds	.34	.15	.24		.49		.31
*G. R. D. T. X, 2, Recognition Sounded Letters	.23	.02	-.10				.05
*G. R. D. T. X, 3-4, Giving Initial and Final Sounds	-.19	.33					.07
*G. R. D. T. XIII, 1-2, Write Words	.11	.20					.16
*G. R. D. T. IX, 10, Recognition Capital Letters	.22	.36					.29
*G. R. D. T. IX, 11, Recognition Small Letters	.07	.40					.24
*G. R. D. T. XV, 2, Memory Span, Letters	.36	.66	.41		.27		.45
*G. R. D. T. XIII, 3, Adapted, Writing Capital and Small Letters and Digits	.43	.55	.23				.40
Averages	.19	.331	.195		.38	.33	.246

*Gates Reading Diagnosis Tests

Table 5 is for the correlations of the performance tests with letter abilities Most of the coefficients in this group are for the Seguin and the Mare and Foal time measures. The "finder device" indicated that nearly all the coefficients

for the other performance tests and letter abilities would be very low, and so they were not computed. The averages of 13 correlations of Seguin with letter tests was .19; that of twelve correlations of Mare and Foal time with letter tests was .33. The large variability in the size of the correlations seems reasonable when the strikingly different abilities of the letter tests are noted. For example, writing letters is quite different from giving phonic combinations or words beginning or ending with the same sounds. The figures show little, if any, significant relationship between performance tests and letter abilities.

TABLE 6

CORRELATIONS OF PERFORMANCE TESTS WITH MEASURES OF MENTAL ABILITY

	Seguin	Mare & Foal Time	Mare & Foal Errors	Mani-kin	Ship	Healy II	Aver-age
Van Wagenan Reading Readiness Test, Information	.59					.53	.56
Van Wagenan Reading Readiness Test, Relations					.43		.43
*H., G. O. M., T. Sentences			.24				.24
*H., G. O. M., T. Numbers	.43					.31	.37
*H., G. O. M., T. Information	.44			.39		.41	.41
*H., G. O. M., T. Total	.45	.40			.41	.49	.44
*H., G. O. M., T. Drawing Man		.40	.60			.46	.49
Vocabulary, Total	-.11	.04	.00			.22	.04
Mental Age, Stanford Revision of the Binet-Simon Test	.33	.47	.21	.21	.45	.32	.35
Intelligence Quotient, Stanford Revision of the Binet-Simon Test	.10	.54	.44	.04	.37	.11	.27
Gates Reading Diagnosis Tests, Total XV, 1-4, Memory Span, Total	.34	.68	.42				.48
Averages	.32.	.42	.32	.21	.42	.36	.369

*Hildreth, Griffith, Orleans Metropolitan, Readiness Test for Kindergarten and Grade I, ---

Table 6 gives correlations of the performance tests with other measures commonly held to be those of mental abilities. These correlations were a little higher than those for reading and letter abilities, as might be expected, but the averages for the several performance tests were not high, varying from .21 to .42. The Mare and Foal time and the ship tests gave higher correlations with Binet mental age and intelligence quotient than any of the others, although the probable errors of the correlations make the differences meaningless. Comparison of the two correlations of the intelligence quotient with the Mare and Foal and the Healy test is quite striking, .54 as compared with .11. The correlations of these two performance tests with mental age were much more similar, .47 and .32 respectively.

TABLE 7

CORRELATIONS OF PERFORMANCE TESTS WITH PSYCHO-PHYSICAL MEASURES

	Seguin	Mare & Foal Time	Mare & Foal Errors	Mani-kin	Ship	Healy II	Aver-age
Gates Reading Diagnosis Tests, XIII, 3, Adapted, Writing Capital and Small Letters and Digits, Time	.08	-.00		.02			.03
Vocabulary Time	.26	.13		.01			.13
Perception	.36	.18	-.08	.35	.09	.33	.21
Steadiness (hole apparatus)				.39			.39
Tapping, Whipple and Healy	.16	-.07	-.01				.03
Perseveration, Elkins and		.22	.27	.42	-.03	.14	.17
Maller Attention Test	-.03	-.07	-.24	.24	.15	.40	.12
Chronological Age	.24	.01	-.16	.40			.17
Grip	.42						
Motor Coordination (Battery of six tests)	.36			.54			.45
Weight	.17	-.07	-.20				-.03
Height	.27	-.06	-.00				.07
Nutrition (variation from height-weight-age norms)	-.07	-.08	-.21				-.12
Developmental Index (Babyhood)	.28	.05			.13	.24	.17
Averages	.21	.02	-.08	.30	.09	.28	.138

TABLE 8

CORRELATIONS OF PERFORMANCE TESTS WITH PERSONALITY MEASURES

	Seguin	Mare & Foal Time	Mare & Foal Errors	Mani-kin	Ship	Healy II	Aver-age
Reversals, Visual Perception (letters, digits, words, numbers)	.24	.24	.22	-.15	.14	.07	.13
Reversals, Auditory Perception (letters, digits, words, numbers)	.20	.16	.05	.15	-.13	-.10	.05
Undesirable Behavior and Traits	.36	.08			-.34	.07	.04
Personal Traits	-.04	.21			-.46	-.03	-.08
Personality Rating, Hicks, A Personality Rating Scale for Children Six to Nine	.23	.24			-.43	.19	.06
Averages	.20	.184	.14	.00	-.25	.04	.04

TABLE 9

FREQUENCIES OF CORRELATIONS OF TABLES 4-8
_____Performance Tests with_____

Range	Reading	Letters	Mental	Psycho-Phys.	Pers'y.
.60 to .69			2		
.50 " .59	5	2	3	1	
.40 " .49	9	6	14	4	
.30 " .39	3	10	6	6	1
.20 " .29	3	5	4	8	7
.10 " .19	8	5	2	7	4
.00 " .09	5	2	3	6	4
-.00 " -.09		1	0	12	2
-.10 " -.19		2	1	1	3
-.20 " -.29				3	0
-.30 " -.39					1
-.40 " -.49					2
Number	33	32	35	47	24
Averages	.304	.269	.364	.127	.049
S. D. Distribution	±.176	±.168	±.175	±.200	±.224

Table 7 gives the correlations of the performance tests with psycho-physical measures. The coefficients are low as might be expected. The averages for the six various performance tests ranged from -.08 to .30.

Table 8 shows that the averages of the correlations of the performance tests with measures of personality were the lowest of all the groups, ranging from -.25 to +.20. The three fairly high negative correlations of the ship test, with personal traits, -.46; with personality rating, -.43; and with (few) undesirable traits, -.34, seem peculiar, as no such tendency appeared with any of the other performance tests. In fact, the opposite tendency is indicated by .36, the correlation for the Seguin Form Board with (few) undesirable traits, .24, for Mare and Foal time with personality rating; and .23, for Seguin with personality rating. It seems improbable that even such moderate negative relationships as shown by the figures for the ship test should be the rule.

Table 9, gives, for convenience, the frequencies, averages, and standard deviations of the computed correlations of all the performance tests and the other measures by the groupings shown in Tables 4-8. This table seems to indicate that the performance tests were somewhat related to abilities. A slight relationship with psycho-physical abilities may have been present. In general, no relationship of consequence appeared between the performance tests and the personality measures used.

CONCLUSIONS

It would seem that the small degree of relationship shown by the coefficients of correlation reflects, in general, the true relationships between such abilities in the organization of young children's natures. The tendency toward low correlations as found in this study is in accord with the present theories of the relatively unintegrated nature of abilities and traits of young children, as proposed, for example, by Hartshorne and May in their study of Organization of Character and by Miss Shirley in her three year study of infants. If this fact be true for such children as those tested in this investigation it raises the problem in first grade teaching of the nature of the guidance to be given by the teacher. Reports of other studies, and of other phases of the Horace Mann School study of which this is a part, indicate that the guidance which recognizes the particular and individual nature of maturing abilities and maturing organization promises the greatest good in both learning and personality development. In other words, teaching of young children which is characterized by insight into the nature and needs of each child, is better than teaching according to a system or to a fixed course of study.

A COMPARISON OF FOUR CURRENT METHODS OF ESTIMATING PHYSICAL STATUS

EVERETT L. MARSHALL [1]

A study showing the extent to which over- and under-weight occurred for 77 boys according to the Baldwin-Wood age-height-weight table, the Pryor and Stoltz age-hip-height-weight standards, the Franzen and Palmer ACH Index, and the McCloy age-height-hip-chest-knee-weight standards.

INTRODUCTION

An unusual interest in child development together with the desire to be able to appraise the physical status of the individual has led to the development of several anthropometric techniques for this purpose. The oldest and most widely known of these anthropometric standards is the Baldwin-Wood age-height-weight table[2] which was published in 1925 (1). As may be inferred from the title, this table estimates the normal weight for the individual, given his age and height.

In 1933, Pryor and Stoltz (4) reported a method of estimating normal weights which is a variation of the Baldwin-Wood table. In addition to height, the bi-iliac width of the hips is employed to ascertain the normal weight of an individual of a given age and sex.

The ACH Index of nutritional status, devised by Franzen and Palmer (2), appeared in 1934. This index was derived to enable school health workers to select from a given group of school children those individuals who are underweight and probably in need of medical or nutritional attention. It functions in the following manner. If for any individual between 7 and 12 years of age the difference between the sum of two arm girths (one with arm flexed and the other with arm extended) and the sum of two chest depths (inspiration and expiration) is less than a certain amount for a given age and hip-width (bitrochanteric), the individual is estimated as being underweight. Those indicated as underweight by the ACH Index (about 10 per cent of a representative group of American school children) are given a more thorough examination and according to the originators of the technique, more than 80 per cent of those given the intensive examination are either "extreme defect cases or border line cases." Franzen and Palmer note that some cases of marked "underweight condition" are missed by the ACH Index but claim that the number here is comparatively few.

In common with all the standards thus far discussed, those developed by Professor C. H. McCloy (3) of the Iowa Child Welfare Research Station estimate the normal weight of an individual by first taking age and sex into account. The tables, specific for age and sex, have been compiled by the use of multiple regression equations. The normal weight for an individual - given his height, hip width (bi-iliac), chest circumference, and knee width - is readily obtained by the use of these tables.

[1] From Department of Psychology, Illinois State Normal University, Normal, Illinois.

[2] The first weight-height-age table created by Wood appeared as early as 1910.

The purpose of this study is to apply each of these four techniques to a group of boys and to compare the results. No attempt is made to claim superiority for any of the procedures.

SUBJECTS

The subjects for this investigation were 77 boys between 7 and 12 years of age who were in attendance at the University of Iowa elementary school during the spring of 1935. All measurements needed to employ each of the four techniques were taken at one measurement period.

PROCEDURE

The physical status of the 77 subjects was estimated by each of the four techniques. The ACH Index does not yield ratings that may be converted into given per cents of over- or underweight but merely indicates those individuals who are suspected of being underweight. In the case of the three other methods, the individual's normal weight is estimated and per cents, such as those presented in the following table, are found by dividing the actual weight of each individual by his estimated weight.

TABLE I

TABLE SHOWING THE RESULTS OBTAINED BY EACH OF FOUR METHODS OF ESTIMATING PHYSICAL STATUS

Per cent of normal weight	Baldwin-Wood		Pryor & Stoltz		C. H. McCloy		ACH Index	
	No. of cases	Per cent	No. of cases	Per cent	No. of cases	Per cent	No. of cases	Per cent
151-175	2	3						
126-150	3	4	3	4				
116-125	3	4	1	1	1	1		
96-115	51	66	17	22	58	75		
86- 95	16	20	34	43	18	23	Underweight	
70- 85	2	3	22	29			4	5
Range	65-172		71-143		89-123			

The zone of normal weight is considered to extend from 96 to 115 per cent. Thus 66 per cent of the boys fall within the normal zone by the Baldwin-Wood table, 22 per cent within the normal zone by the Pryor and Stoltz standards, and 75 per cent within the normal zone by the McCloy tables. It is further obvious from Table I that the per cents "underweight" by each of the four methods under consideration present notable disagreement. This disagreement is analysed in greater detail in Table II, where the overlapping and lack of correspondence of the underweight cases[1] for each method is shown.

[1] "Underweight cases" are all those cases whose actual weight is 95 per cent or less, of their weight, as estimated by any of the four methods under consideration.

TABLE II

Table showing the overlapping and disagreement in underweight cases. In the first column is given the number of cases underweight according to each method. The other columns show where the cases which are estimated underweight by a given method are placed by each of the other methods, i.e., whether they are considered underweight, normal or overweight.

Underweight cases	Baldwin-Wood			Pryor & Stoltz			McCloy			ACH Index		Pryor & Stoltz(a)*
	U	N	O	U	N	O	U	N	O	U	N-O	U
Baldwin-Wood 18	18			18			11	7		2	16	10
Pryor & Stoltz 56	18	38		56			18	38		3	53	22
McCloy 18	11	7		18			18			3	15	6
ACH Index 4	2	2		3	1		3	1		4		3
Pryor & Stoltz(a)*22	10	12		22			6	16		3	19	22

*The 22 cases in this group weighed less than 86 per cent of their estimated weight according to the Pryor and Stoltz standards. Note that only 10 of the 18 underweight cases according to the Baldwin-Wood table are in this lowest group for the Pryor and Stoltz standards, etc.

Some of the important points derived from Table II are:

1. Of the 18 subjects who are underweight according to the Baldwin-Wood table, all are in that category on the full Pryor and Stoltz standards but only 11 and 2 are estimated underweight by the McCloy tables and the ACH Index, respectively.

2. Of the 56 cases found underweight by the Pryor and Stoltz standards 18 are underweight according to both the Baldwin-Wood and McCloy tables yet only 3 (less than 6 per cent) are underweight by the ACH Index.

3. Of the 22 cases below 86 per cent on the Pryor and Stoltz standards 12 cases are in the normal group on the Baldwin-Wood table, while 16 and 19, respectively, are in that class according to the McCloy tables and the ACH Index.

4. As on the Baldwin-Wood table, 18 subjects are underweight by the McCloy standards. Only 11 of these subjects, however, are the same for both groupings. *Of the 18 underweight cases by the McCloy standards as few as 3 (one-sixth)* are in that group according to the ACH Index.

5. One of the 4 cases designated as underweight by the ACH Index is in the normal group according to the McCloy and the Pryor and Stoltz methods, while two of these 4 cases are estimated as normal by the Baldwin-Wood table.

It appears from the preceding tables that the Baldwin-Wood table and the McCloy standards yield somewhat similar results. However, there are several extreme cases in the former distribution which are not present in the latter. Two subjects have per cents above 150 on the Baldwin-Wood table but on the McCloy standards these are 115 and 123, respectively, while the Pryor and Stoltz standards place them at 132 and 143. The results procured by the ACH Index and the Pryor and Stoltz standards disagree markedly. The former method indicates that only 5 per cent of the cases are below normal while 72 per cent are in that category according to the latter. The Baldwin-Wood table and the McCloy standards each indicate that 23 per cent of the cases are in the underweight group. No obvious causes of the varied results were apparent and re-checking of findings yielded none.

The mean for each age on the McCloy tables was compared with corresponding means on the Pryor and Stoltz standards in search of a possible explanation of the diverse results but the differences were found to be negligible.

SUMMARY

Four methods of estimating physical status: the Baldwin-Wood age-height-weight table, the Pryor and Stoltz age-hip-height-weight standards, the Franzen and Palmer ACH Index, and the McCloy age-height-hip-chest-knee-weight standards were employed on 77 subjects.

The results obtained by the application of the Baldwin-Wood tables and the McCloy standards were similar but those secured by the Pryor and Stoltz standards and the ACH Index were heterogeneous.

There was considerable lack of agreement found, i.e., the subjects with a low per cent according to one method were frequently in the normal zone according to another method.

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THE EFFECT OF THUMB AND FINGER SUCKING ON THE PRIMARY TEETH AND DENTAL ARCHES [1]

SAMUEL J. LEWIS [2]

Several fundamental questions may be asked about this matter of the effect of thumb and finger sucking on the primary teeth and dental arches. For example, do these habits cause deformities? If so, do they cause a specific type of deformity? How early may it be observed? Do all thumb and finger suckers produce deformities? Is there any relation between the manner in which the thumb is sucked and the presence or absence of deformity? Are there any established facts to prove that thumb or finger sucking causes deformities? What happens when the habit presists, and what happens when it is broken? Are mechanical appliances such as the orthodontist uses indicated to correct such deformities in the primary dentition?

With these and other questions in mind, I started in 1924 a systematic study of the growth and development of the teeth and dental arches of the Merrill-Palmer nursery school children. My method was to make yearly records of their dental conditions, including impressions of their teeth and dental arches from which models were made. These individual series of models, together with the many concurrent data on other aspects of growth and development taken at the school, gave me a tangible record of the localized changes incident to dental growth and development from which many studies could be made.

In 1929 I began a survey of the conditions of the occlusion of the teeth, and among other things noted a certain similarity in the type of dental arches of a number of the children. The models of these children were segregated for study and their histories examined. In each case there was a definite history of thumb sucking at sometime or another in the life of the child. I then looked over the models of the other children to see if I could find other types of occlusion associated with this habit. I succeeded in finding six cases of children who had histories of sucking the thumb but who presented no deformities. These were laid aside for further study.

From a study of the histories of these cases, thirty in all, I learned that all but two had started to suck their thumbs during the nursing period, and that twenty one had been broken of the habit between the first and the sixth year of age. Eight were still sucking their thumbs. On one we could get no report.

What was the result of this study? Figure 1 shows the type of thumb sucking that did the most damage to the shape of the arch. Here you will note that the thumb is sucked with the volar surface toward the palate. There is considerable pressure exerted on the teeth and the premaxillary bone, which until the child is seven years old is likely to have its sutures still open. Recent experiments have

[1] From report presented at Symposium on Primary Teeth held at Second Biennial Meeting of the Society for Research in Child Development in Washington, October, 1936.

[2] From Detroit, Michigan.

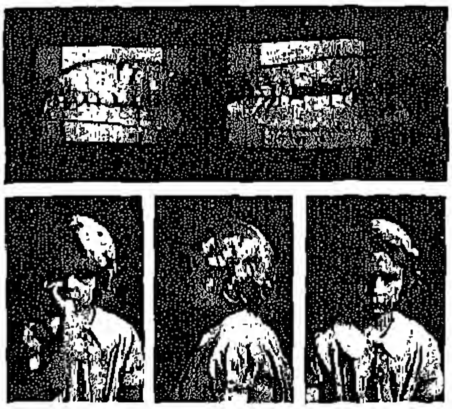

Figure 1. Type of thumb sucking which causes the most damage. Note the volar surface towards the palate.

Figure 2. Types of deformities of the dental arches caused by thumb sucking.

shown that four ounces of pressure from a wire spring of but .020" in diameter are sufficient to move a tooth in the surrounding bone. The pressure from the thumb is manyfold greater than this.

Figure 2 shows the types of deformities caused by thumb sucking. The deformity is characterized by a forward displacement of the upper front teeth and sometimes a retrusion of the lower teeth. If the right thumb is sucked the displacement is towards the right; if the left, towards the left; and if both thumbs are sucked the displacement is symmetrically forward.

But in these cases all the primary teeth were in place. They did not tell me how early the deformity appeared or whether it was perceptible before the primary teeth were erupted. In 1930 I examined a group of babies in one of our hospitals, making casts of their toothless jaws when they were as young as one month of age. Figure 3 shows the normal shape of a baby's dental arches. They are round and more or less symmetrical. Figure 4 shows some of the palates of babies who sucked their thumbs. You will notice the deflections caused by the sucking habit.

During the course of my study I received a letter from Dr. Henry Klein, who was at that time working with Dr. E. V. McCollum at Johns Hopkins University. He wrote that he had under observation a monkey which had been sucking its fingers for three years, and which presented a deformity very much like that seen in children. Figure 5 shows the deformity, and you can see for yourself that this is no monkey-shine. The motion picture of this monkey shows that he sucked the fingers with the volar surface towards the palate.

Having satisfied myself that thumb sucking could produce a deformity of the primary teeth, I began to study successive models of our cases to see what happened at later periods. Figure 6 illustrates a case where the habit persisted until three years of age and was then broken. A full correction of the deformity took place within a year and a half. Note in the first model to the left that the lower anterior teeth retrude. This seems to happen when the thumb is pushed against the upper teeth and the lower teeth are used as a sort of fulcrum. This case represents one of self correction, or perhaps better still, a spontaneous correction by nature due to the breaking of the habit.

What happens if these children resume the habit after it has been broken and a self correction has taken place? The child whose models are shown in Figure 7 was broken of the habit and there followed the usual self correction of the deformity. Later, however, during a serious illness, she again took up the habit, with the result that the permanent teeth were pushed out of position just as the primary ones were.

I found further that in children who had a deformity coexistent with the habit and who persisted in sucking their thumbs, even for a short time before going to sleep, there was no self correction of the deformity, which either remained the same or became progressively worse. Figure 8 illustrates one of that type. The child was still sucking his thumb when the last model was made.

Figure 9 shows an interesting case. The right thumb was sucked producing,

Figure 3. Normal shape of a baby's dental arches.

Figure 4. Palates of babies who sucked their thumbs. Note the deviation from the symmetry seen in Figure 3

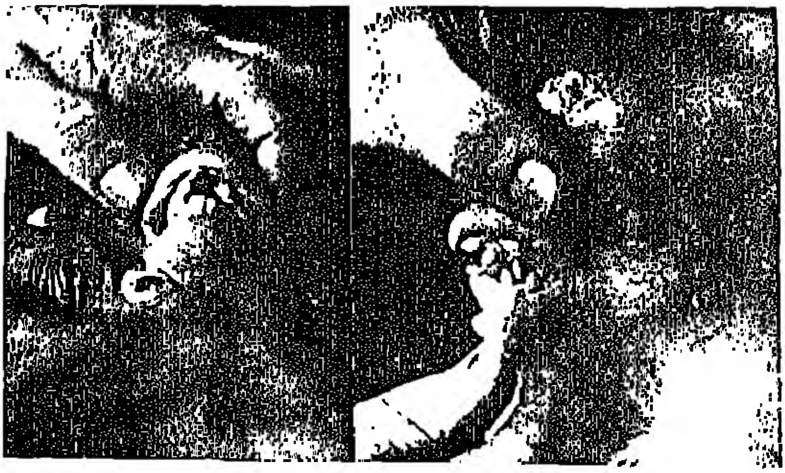

Figure 5. A Macacus Rhesus monkey who sucked his fingers. Note the similarity of the deformity to that of the child shown in Figure 8.

Figure 6. Showing a case of self correction of the deformity caused by thumb sucking following the breaking of the habit at 4 years of age.

Figure 7. A case of self correction of the thumb sucking deformity followed by the reappearance of the deformity after the habit was resumed.

Figure 8. A case of thumb sucking deformity in which the habit was not broken. The deformity still exists in the permanent dentition.

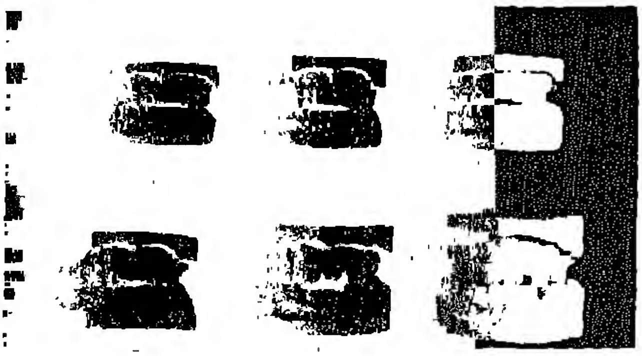

Figure 9. Deformity caused by sucking the right thumb. Besides the anterior protrusion there was an open bite. After the habit was broken at 9½ years, both the protrusion and the open bite corrected themselves.

besides the displacement, what is called an open bite. The habit persisted until the boy was about nine years old, when he was shamed by his schoolmates into breaking it. The last model on the right in the lower row shows what happened to his occlusion. There has been a definite improvement, and had he not gotten into the hands of an orthodontist who knew nothing of the history of the case, I believe that his occlusion would have been normal without the use of appliances.

I know that you must by now be thinking of what happened to those six cases where there was thumb sucking but no deformity. Their histories show that all six were broken of the habit sometime between the first and second year of age, or sometime before they entered the nursery school. In the light of my discoveries concerning the relation between thumb sucking and deformity of the primary dental arches, I was satisfied that either the deformity corrected itself before I saw the children, or that they sucked the thumb in other ways than with the volar surface toward the palate. This I cannot prove, but it seems to me a logical conclusion. Now, then, what are we to do in the way of treatment? Should we correct these cases through the medium of orthodontic appliances, or should we attempt to break the habit and wait for results? Where the primary teeth are involved, the latter procedure seems to be the better one. While I have seen self-corrections as late as the tenth or eleventh year of age, they do not always occur even if the habit has been broken. Some of these cases can be broken of the habit only by correcting the deformity through the medium of appliances such as the orthodontist uses. A new environmental condition is then produced and the thumb, having no longer the place to rest that it had before the deformity was corrected, ceases to find its way to the mouth. Figure 10 illustrates such a case. This child sucked the forefinger with the volar surface towards the palate and the habit had persisted since she was a baby. Note the type of deformity that was produced. All methods of breaking the habit failed until the deformity was corrected with orthodontic appliances. The correction was followed by a complete cure of the habit, and the teeth "Stayed put." The child told me later, "I can now smile without having to hold my hand over my mouth."


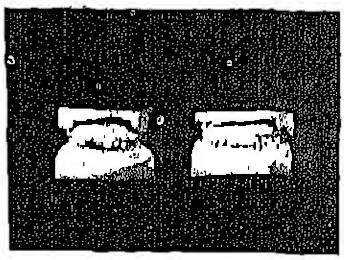

Figure 10. A case where the right forefinger was sucked from infancy with the volar surface towards the palate. The habit was finally broken by treating the malocclusion with orthodontic appliances.

THUMB OR FINGERSUCKING FROM THE PSYCHIATRIC ANGLE [1]

DAVID M. LEVY [2]

Previous observations and clinical studies have demonstrated that the primary cause of fingersucking is insufficient sucking at breast or bottle. This was determined first by a study of numerous feeding histories. In the case of families in which some children had the sucking habit and the others were free of it, it could always be shown that the former had less sucking activity than the latter. It was shown also that when the habit started after the first few weeks of life it was definitely related to a diminution of sucking-time. In the case of children whose sucking started after birth, though in the first week of life, it was shown that there was a diminution of sucking-time because of the rapidity of the flow of milk from breast or bottle. Statistical evidence demonstrated that the percentage of fingersucking problems is also consistent with the sucking-time, rising as high as 40 per cent in infants fed at four-hour intervals to as low as 6 per cent in unscheduled feeders. The conclusion that sucking-time is the primary factor in the etiology of fingersucking was aided by the following observations. There was not one instance of fingersucking in the case of children who used pacifiers. In several cases of children with rickets, whose feeding histories showed sufficient sucking-time, the habit did not develop, thus ruling out the nutritional factor as a primary cause. In an experiment with an infant of 8 months, whose thumbsucking started when feeding from a glass was substituted for one bottle feeding, the sucking was stopped by a return to the bottle and started again by a return to the glass. In another case, an infant of 6 months, who sucked his finger immediately after each bottle feeding, it was demonstrated that by using a nipple with a fine hole, increasing the sucking-time to 25 minutes, the finger did not go to the mouth after the feeding.

Further proof was added from observations and experiments with animals. The calves of dairy cows show a marked contrast with the calves of beef cows, in that the former develop various licking habits which do not occur in the latter. The calves of dairy cows, unlike the others, do not suck from the udder but are fed from a bucket and hence do not satisfy their normal sucking needs.

An experiment was made of four pups in a litter in which the sucking-time could be accurately determined. The two pups with diminished sucking-time developed perverted sucking, in the form of sucking their own bodies or straw or towels, or sucking each other's bodies. In the experiment all other conditions, including nutrition, were constant.

Studies in the pecking activity of chickens demonstrated a similar principle, namely, that the energy generating instinctive behavior of the pecking type is far in excess of the requirements of nutrition; as also in sucking, and also, for example, in sexual activity, in which the sexual impulses are far in excess of

[1] Abstracted from paper presented at Symposium on Primary Tooth held at Second Biennial Meeting of the Society for Research in Child Development in Washington, October, 1936.

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the needs of procreation. 200 ten-day-old chicks were divided in two groups. Both were brought up under the same conditions of food, light, indoor and outdoor space. The experimental group was raised about two inches from the ground by means of a half-inch wire mesh. Within five weeks the chicks on the wire showed in every instance patches of denudation where they had pecked off the feathers. In contrast, the control group showed but two instances of denudation, of a minimal degree. The difference was due obviously to the fact that the needs of pecking were inadequately released on the wire.

The discrepancy between sucking needs for the purpose of nutrition and sucking needs as a pleasurable activity was recognized by Freud. It was on the basis of this observation, namely, a cleavage between the pleasurable and nutritional phases of the feeding act, that he developed the theory of erogenic zones. These represent areas of tension in the body relieved with pleasurable sensation.

In the case of thumbsucking and in other forms of sucking habits, there is often a movement of the other hand that accompanies the sucking act. This movement has been called an accessory movement and has been traced to movements that were made by the free or locked hand while at the breast or bottle. Such movements may become so integrated in the pattern of the sucking act that the sucking cannot continue without them. For example, consider the case of a child whose accessory movements while thumbsucking were holding of an object. When the object was removed, the thumb left the mouth. Cases have been observed also in which initiation by the observer of the accessory movements was followed immediately by thumbsucking. For example, a child whose accessory movement was feeling its hair could be started sucking when the observer felt its hair. In the case of a child who sucked its thumb only while feeling silk, the very specific accessory movement was traced to movements of the finger on a silk wrapper which the mother always wore when she fed at the breast.

So-called accessory movements often occur without thumbsucking. A number have been traced to movements while feeding at the breast or bottle, without the development of sucking habits. Such movements have been thought to derive their "strength" from their original association with a pleasurable feeling during the sucking act; for example, hair stroking, hair pulling, pinching of skin, rotary movements of finger tips or of the hands. Another source of such movements is the concealing or masked movement. In thumbsucking, such movements arise to conceal the sucking act, usually by bringing the palm of one hand over the sucked hand. More frequent is the attempt to conceal a deformity to which the child has been made sensitive, such as scars, etc., especially crooked teeth. These movements may be of tremendous consequence. They involve various finger play to the teeth or mouth, or laughing with the palm over the lips, but probably become more important as an actual limitation of the excursion of the lips in smiling or talking, in order to conceal the crooked teeth (often a result of fingersucking). The latter activity would aid not only in offsetting spontaneous conversation, introducing a consistent self-conscious factor into social relationships, but in increasing the amount of lip tension and hence, theoretically, increase the erogenicity of the oral zone.

Such movements also result from the attempt to modify undesirable movements and

are hence modifications of them. For example, nail biting is often a modification of thumbsucking. Other modified movements in the case of thumbsucking are running the finger tips over the lip area, lip sucking or biting, merely keeping the fingers to the lips, finger restlessness, constant tweaking of the fingers, running one finger tip under the other, etc.

Psychoanalytic investigations have traced the formation of certain personality traits to erogenic zones. Out of this a characterology has arisen by which physiologic behavior becomes translated into social behavior. A prolonged fingersucking, involving, as it does, retention of the finger in the mouth for long periods of time, would become correlated with retention in the psychological sense, or hoarding. The activity of getting objects to put in the mouth would become correlated with enterprise, or with grasping in the psychological sense. In relation to the mouth area, these "character formations" are still speculative inferences. In regard to the anal zone, however, such correlations have a more convincing body of clinical evidence to support them.

In general, psychiatric advice as to the fingersucking habit has been to ignore it. Such advice has been given on the basis that the child evidently needs the sucking it derives in this manner, and, if it does no harm, there is no reason to interfere with it. When there is no question that it is harmful, psychiatrists have generally been at a loss as to methods of dealing with it. The harm occurs in those cases in which the absorption in the act is sufficiently great to prevent normal interest in other activities, in some cases even to ordinary learning. Besides the harm of excessive sucking, there is the danger of malformation of the jaws, especially the overbiting and spacing of the upper incisors due to the pressure of the volar surface of the thumb against them. Malformation of the palate, also, has been traced to sucking. The problem of malformation due to thumbsucking has been pretty well settled by the work of S. J. Lewis. Ordinary observation of the type of sucking that the child employs will easily determine whether a malformation is likely.

In regard to advice as to the prevention of the act, psychiatrists seem to be puzzled like everyone else. Their hope is generally that the sucking habit will stop once the emotional difficulties of the child are solved, since, as is well known, a fingersucking child will utilize the habit especially when it is in a state of emotional tension. Appeals have been made directly to the child to stop the habit, by boosting his ego, by explanation of the possible harmfulness of the act, etc. Since such methods are often unsuccessful, recourse has been sought to the old inhibitory devices of mechanical restraints and bitter tasting chemicals on the finger tips. Rationally, according to the studies described, the prophylactic and also the direct therapeutic device in infancy consists in a return to the use of the pacifier. The arguments against its use are based either on inferences about the pacifier as a source of infection, which has not been proven, or on certain abuses of it, which are no longer necessary. Methods in older children must be combined with various types of activity that release tension of lips and fingers.

THE EFFECT OF NUTRITION ON THE PRIMARY TEETH [1]

FREDERICK F. TISDALL [2]

The deciduous teeth begin to calcify about the fifth month in utero, calcification of the crowns being completed towards the end of the first year of life, and the roots during the third year of life. It is therefore evident that the diet of the child during the first three years of life can affect the nutrition of the deciduous teeth during their period of calcification.

Dr. Martha M. Eliot and her co-workers (1) examined the teeth of children who had been examined some years before for the presence or absence of rickets. This examination showed a definite relation between hypoplastic defects of the enamel of permanent teeth and rickets. In regard to the deciduous teeth, Dr. Eliot found there was a slight preponderance in the incidence of hypoplastic defects of the enamel in the children who had had severe rickets. In a discussion of this paper, Dr. Alfred Hess stated that he had found many more cavities in the teeth of children with rickets in infancy than in those who had been protected against rickets.

A study on the effect of nutrition in relation to tooth decay has been made in Toronto and reported by Anderson et al (2). In planning this investigation a survey was made of the supply of the various dietary factors necessary for normal nutrition. It was found that even under excellent dietary and hygienic conditions the average Canadian child does not receive any vitamin D for many months of the year unless it is specifically administered. The vitamin D value of sunshine in Toronto takes a very marked drop about the 15th of October and remains at an extremely low level throughout the winter months (3). This combined with the necessity for bundling up the child means that very little vitamin D effect is obtained from sunshine in Canada and the Northern part of the United States from the middle of October until the middle of April, which is approximately one-half of each year. A study of the vitamin D content of ordinary foods (4) has shown that it would require 890 servings of spinach, 1560 servings of beets, or 4000 servings of lettuce to furnish the vitamin D equivalent of one teaspoonful of cod liver oil. The only food commonly used by children which contains appreciable amounts of vitamin D is egg yolk, and from a survey of eggs obtained in the open market in Toronto, it was found that it required approximately 14 egg yolks to furnish the equivalent of one teaspoonful of cod liver oil (5). E. V. McCollum has drawn attention to the fact that there are no less than 37 individual food elements which must be supplied in adequate amounts for the development and maintenance of optimal health. It is not impossible that a lack of vitamin D, which is one of these 37 food elements, would impair the health of the child, and this impairment might show itself in an increase in tooth decay. Accordingly, the investigation was planned to show whether this lack of vitamin D had any effect on the development of tooth decay.

[1] From report presented at Symposium on Primary Teeth held at Second Biennial Meeting of the Society for Research in Child Development in Washington, October 1936.

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Children living in an institution were observed over a period of one year. Their diet during this time supplied all the food elements ordinarily considered necessary with the exception of vitamin D. The children in the institution were divided into two groups. One-half continued on the standard diet, while to the diet of the other half was added vitamin D daily, the administration of this being facilitated through its incorporation in a small biscuit. At the beginning and at the end of the year a careful dental examination was made which included not only hard tissue examination but also bite-wing x-rays on every child. Final examinations were recorded without the dentists having any idea as to which group the children belonged. When the results were tabulated, it was found that in the group given the standard diet, which is deficient in vitamin D, the incidence of caries in the deciduous teeth was more than double that found in the other group of children receiving exactly the same diet but with added vitamin D (Table 1).

TABLE 1

Incidence of Caries

Average Number of Cavities per Child in Deciduous Teeth

	CONTROL GROUP (75 Children)	VITAMIN D GROUP (87 Children)
Non-Progressive	3.0	4.67
Slightly Progressive	0.05	0.19
Markedly Progressive	0.7	0.26
New Cavities	0.46	0.22

It is of interest to consider for a moment the pathological process involved in tooth decay. In tooth decay, the infecting organism enters the tooth from its surface. This entrance is probably accomplished through a local injury or defect of the hard enamel of the tooth. A local injury may be produced by acid from acid-forming bacteria. The well-known work of Bunting and his co-workers of Michigan indicates that the Lactobacillus acidophilus organism is the important factor in this injury. In a recent study reported from this clinic (6), we have shown a correlation between the presence of Lactobacillus acidophilus in the mouth of children and the presence of active tooth decay. The Michigan group of workers have shown that when sugar is fed, the growth of this bacterium is facilitated. It is believed that sticky particles of food containing large amounts of sugar become lodged over a certain area of the tooth. This forms a most excellent culture medium for the growth of the Lactobacillus acidophilus, which accordingly develops in small circumscribed areas, where the sticky particles are kept in continuous contact with the tooth. As the organism develops, it produces acid which can etch and injure the surface of the enamel, comparable in a way to a cut or injury to the skin. Through this injured area organisms proceed down the interprismatic cementing substance of the enamel, and thus tend to disintegrate it. As the infection proceeds further into the tooth, it reaches the more vascular dentin layer of the tooth with resultant liquefaction of the tissue and the production of the tooth cavity with which most of us are unfortunately quite familiar.

With this knowledge of the pathological process of tooth decay, how can it be

prevented by dietary means? Tooth decay can be prevented by - (a) The reduction of carbohydrate in the diet in the form of sugar. This removes a favorable medium for the growth and retention of acid-producing organisms (Lactobacillus acidophilus) in the mouth. (b) The administration of a diet built up around milk, meat, eggs, vegetables and fruit, with added vitamin D, which will tend to result in optimal health. Whether this diet acts by increasing the resistance of the tooth itself, or by changing the physical, chemical or bactericidal characteristics of the saliva, is not known. The fact remains, however, beyond any doubt, that the administration of this type of diet with its comparatively low sugar content does decrease tooth decay and tends to develop normal healthy teeth.

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IDENTIFICATION BY YOUNG CHILDREN OF DIFFERENTLY ORIENTED VISUAL FORMS

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INTRODUCTION

A distinction has been made between visual shape and visual form (2). The stimulus essential for shape has been considered to be a differential light distribution, the perception of shape depending, merely, on unequal stimulation of different retinal parts. Perception of form *qua* form would not be present unless discrimination of the given figure persisted regardless of its orientation in the normal plane. Bingham trained his chick to discriminate an erect triangle from a circle, but when the triangle was inverted the chick could no longer discriminate it from the circle (1). This was an instance of shape but not form perception.

Various differentiae of form *per se* have been offered (7), but independence of rotation of the positive stimulus has remained a criterion of peculiar interest in animal and child experiments. As noted above, the chick, *Gallus domesticus*, failed to satisfy this criterion of form perception, and the same seems to have been true of the tortoise, *Clemmys japonica* (9). On the other hand, the crow, *Corvus Americanus*, is reported to have suffered inversion of the triangle without disturbance of behavior (3). Discrimination of the white rat broke down on rotation of the figure, though after prolonged training with the figure in 24 different positions the more general capacity to respond to any angular position had been acquired (6). Chimpanzees satisfied the rotation requirement completely by reacting correctly without further practice (7). The same was true of two year old children (7, 10).

Long before the recent interest in the rotation experiment, however, there was a variety of evidence pointing to early form perception in children. Since Preyer's work (12), investigators occasionally have been struck by the frequent mirror-writing of children learning to write, the equanimity with which young children observe books and pictures sideways or even up-side-down, the inversions and rotations found in their drawings and in their attempted copies of divers visual materials (13), or in general, by an apparent indifference among them to abnormal orientations of visual stimuli.

Such observations suggest a greater sensitivity to figure itself than to position, or in Bingham's terms, to form rather than shape. This, together with the impressive evidence by Gellermann for form perception in chimpanzees and children, and the great emphasis on form by the Gestalt psychologists, has favored a view that form is fundamental if not native. On the other hand, the evidence for shape but not form discrimination in lower animals suggests that form is a higher level integration or a function of learning. Field's rat experiment points toward a learned character for form (6).

[1] From the Child Institute of the Psychological Laboratory, the Johns Hopkins University.

The present study is an attempt to devise a more sensitive form of the rotation experiment for the purpose of investigating this problem in children. If the method were made sufficiently sensitive it was felt that perception of form might be found to be a function of age, training, or some other genetic variable.

Attention is here confined to horizontal and vertical reversals, partly because these are particularly interesting positions. Hanfmann, for instance, found that 4 to 7 year old children copied the positions of figures most accurately when the latter were horizontally or vertically oriented (8). There is the physiological fact that the retinas and projection areas are functionally divided vertically. There are, too, Stratton's and Ewart's well-known experiments involving both left-right and top-bottom reversals (4, 5, 14).

PROCEDURE

The principal apparatus employed was the Bailey visual perception test material (11). This consists of a series of twenty acuity charts including nothing but concrete and geometrical figures, and therefore requiring no reading ability. The child is seated ten feet from the chart. He has on a table before him an inclined tray on which may be placed cut-out block-figures like any of those printed in the charts.

The procedure is to expose a chart on the wall after about five figures have been placed at random on the child's tray. These figures include the block corresponding to the charted figure. Then the child's task is to look at the wall chart and the tray, and indicate the figure in the tray which is the same as the test-object on the wall. This procedure may be repeated with smaller and smaller test-objects until normal acuity has been demonstrated or the resolution threshold has been reached.

For present purposes, several variations were made in the administration of this test: (1) Eight of the block-figures, varying in size and form, were sometimes presented in the tray inverted, either left-for-right or top-for-bottom. This was for the purpose of discovering any noticeable effect of the inversion on identification. These experimental or test figures were: chair, horse, candle, boat, rabbit, child, dog, parallelogram. (2) The child indicated identification of all figures by handing them to the experimenter. (3) The experimenter handed the test figures back inverted, in order to see whether such presentation would influence the child's replacement of the figures in the tray. If it did, there would be evidence that the child noticed the inversion. (4) All observing was with binocular vision and controlled illumination. (5) Each child served in four series, reacting to all twenty test-objects in each series. Usually two series could be completed in a single session. The serial order was varied with different subjects.

The experimental variations in the several series were: Series 1, normal; Series 2, test figures left-right reversed in tray; Series 3, normal; Series 4, test figures top-bottom reversed in tray. In all series the test figures were returned to the subject reversed; in Series 1 and 2 the reversal was left-right, in Series 3 and 4 it was top-bottom.

TABLE I

FORM IDENTIFICATION IN RELATION TO ORIENTATION AND AGE OF SUBJECT

Age of subject	60	55	50	45	40	35	Total
Left-right reversed	8	8	38	28	22	8	112
Normal orientation	8	8	37	28	21	7	109
L-r rev./Normal	1.00	1.00	1.03	1.00	1.05	1.14	1.03
Top-bottom reversed	8	8	36	31	25	6	114
Normal orientation	8	8	36	31	29	7	119
T-b rev./Normal	1.00	1.00	1.00	1.00	.86	.86	.96
Total reversed	16	16	74	59	47	14	226
Total normal	16	16	73	59	50	14	228
Tot.rev./Tot.nor.	1.00	1.00	1.01	1.00	.94	1.00	.99

NUMERICAL RESULTS

Identification of reversed figures. Tables I and II summarize the data on the influence of reversal on identification. Table I is arranged to show a relatioh between age of subject and frequency of identification. Age in months at test-time is given in nearest multiples of five in the first row. The second row contains the frequencies of correct identifications of the left-right reversed figures while the third row gives the corresponding values for the normally oriented figures. The next row shows the ratios of the reverse to the normal values. These ratios are not far from unity, a fact which indicates that left-right reversal does not interfere with identification. The next three rows contain the corresponding results on the influence of top-bottom reversals, and again the ratios are indicative of little or no interference. The final three rows of this table compare the totals with like result.

Comparison of the successive columns of Table I shows no trend away from unity, and therefore no functional relationship betwden age of subject and influence of reversal on identification.

Table II is arranged in the same way as Table I except that age has been replaced by size of test-object, as the independent variable. Size is given in the first row in terms of the standard resolution of normal vision. This standard is represented by unity. Thus size 3 is relatively large and could be normally discriminated at three times the distance employed; size 2 at twice the distance, and so on. Comparison of the columns of this table reveals no relationship between size of test-object and influence of reversal on identification.

Replacement of reversed figures. Tables III and IV summarize the numerical data on the influence of reversed returns by experimenter to subject, on normality of replacement by subject. Handing the figure back to the child reversed meant that he would have to turn it himself in order to replace it in the tray

TABLE II

FORM IDENTIFICATION IN RELATION TO ORIENTATION AND SIZE OF TEST-OBJECT

Size of test object	3	2	1.5	1.25	1	Total
Left-right reversed	15	29	14	28	26	112
Normal orientation	15	29	11	28	26	109
L-r rev./Normal	1.00	1.00	1.27	1.00	1.00	1.03
Top-bottom reversed	16	31	11	27	29	114
Normal orientation	16	32	14	30	27	119
T-b rev./Normal	1.00	.97	.79	.90	1.07	.96
Total reversed	31	60	25	55	55	226
Total normal	31	61	25	58	53	228
Tot.rev./Tot.normal	1.00	.98	1.00	.95	1.04	.99

in normal position. The voluntary act by the child of turning the figure would suggest that he was aware of the reversal, for otherwise he could scarcely be expected to make the correction. If the correction was not made there would be less certain evidence that the reversal was not recognized.

TABLE III

NORMAL REPLACEMENT IN RELATION TO ORIENTATION AND AGE OF SUBJECT

Age of subject	60	55	50	45	40	35	Total
Left-right reversed							
Normal replacements	5	9	15	16	7	2	54
Total replacements	16	16	75	56	43	15	221
Normal/Total	.31	.56	.20	.29	.16	.13	.24
Top-bottom reversed							
Normal replacements	16	16	68	55	39	13	207
Total replacements	16	16	72	62	54	13	233
Normal/Total	1.00	1.00	.95	.89	.72	1.00	.89

Table III is arranged to show a relation between age of subject and normality of replacement. The first row gives age to the nearest multiple of five months. The second row shows the frequencies of normal replacements when the test-figure was handed to the child left-right reversed. The third row shows the frequencies of total replacements. In the next are given the ratios of the normal to the total replacements, and they are all seen to be small. This means that the children usually replaced the figures left-right reversed after having received them left-right reversed. The suggestion is that the child was usually not definitely aware of these left-right reversals.

The lower half of the table exhibits the corresponding data on top-bottom reversals and here the ratios are found to be relatively large. This means that the subjects usually replaced the figures normally after having received them top-bottom reversed. The indication is that the child was aware of these top-bottom reversals.

There is no definite indication in Table III of a correlation between age of subject and influence of reversed return on correctness of replacement. Table IV shows no correlation between size of test-object and influence of reversed return.

TABLE IV

NORMAL REPLACEMENT IN RELATION TO ORIENTATION AND SIZE OF TEST-OBJECT

Size of test-object	3	2	1.5	1.25	1	Total
Left-right reversed						
Normal replacements	8	14	8	15	9	54
Total replacements	30	58	25	56	52	221
Normal/Total	.27	.24	.32	.27	.17	.24
Top-bottom reversed						
Normal replacements	24	57	22	53	51	207
Total replacements	32	63	25	57	56	233
Normal/Total	.75	.90	.88	.93	.91	.89

DISCUSSION

Equally accurate identifications of both the reversed and unreversed figures are indicated by the near-unit ratios of Tables I and II. Children from 3 to 5 years of age seem to have reacted immediately and regardless of shape to the particular test figures employed. But there are several reasons for not generalizing this result: (1) most of the test figures were presumably familiar to young children and might therefore have been abstracted from context by experience preceding the experiment. Rats have learned to discriminate form through training. (2) The age-range of the subjects may well have been too short to discover some real form genesis. (3) The subjects' Aufgabe was not improbably a "discriminate form" Aufgabe. Had it been a "discriminate position" Aufgabe, shape rather than form might have been favored. Suitable controls could be exerted on such points.

The reason for having the subject replace test-figures which had been handed to him reversed was to provide behavioral evidence for a distinction between identification of reversed figures and awareness of reversal. In the effort to design a sensitive method, it seemed interesting to discover whether or not identification is independent of awareness of reversal.

Awareness of the top-bottom reversals was clearly demonstrated by the high proportions of corrections. Indeed, there is every indication that these values

would have been maximal except for cases of children playing with blocks known to be up-side-down, and the case of a child who said she returned the blocks reversed "because we do in Sunday School." Frequently a child would make an effort to correct a reversed block in the tray. Frequently, comments would indicate definite awareness of reversals. "Put it up-side-down again." "I want to put it this way." "That's up-side-down." "But the chair isn't up-side-down in the picture." Often the child reversed the block handed to him in a very obvious way, and it seemed clear that he was making intentional correction. Occasionally, the correction was made quite emphatically or impatiently and the experimenter could feel the block being twisted as it left his hand.

The evidence for unawareness of the left-right reversals consists in the low proportions of corrections. These proportions might have been even lower if the experimenter could offer the piece in such a way as to avoid all accidental corrections. Almost always, the pieces seemed to be returned at random insofar as left-right orientation was concerned. There was no impatient twisting of the piece, and only one comment to suggest that a subject had noticed a left-right reversal. In numerous cases where top-bottom reversals were corrected, they remained uncorrected left-right. In brief, there was little to indicate detection of left-right reversals.

Nevertheless, the evidence can not be considered conclusive because the child may have noticed reversals but not have bothered to correct them. There was really nothing strikingly 'wrong' in figures facing either to the left or right. Up-side-down figures, on the other hand, defied the basic gravitational orientation. Furthermore, there were two subjects who did evidence deliberate correction of left-right reversals. One (56 months) remarked that the boat faced the wrong way in the tray and corrected it. She also made correct replacements of the chair, horse, and rabbit. The other (52 months) also corrected several of these reversals. She returned one piece up-side-down (smiling.) These results from older children suggest the possibility that detection of the left-right reversals may be a function of age or training. A greater age-range should be studied.

SUMMARY

1. A method for investigating the form-shape distinction has been described and applied in a preliminary study.

2. The 16 subjects, varying in age from 3 to 5 years, appeared to identify the particular visual figures employed about as quickly and correctly with reversed as with normal orientation.

3. Accuracy was independent of age, over the short age-range available.

4. Accuracy was independent of size of test-object, even down to the standard resolution of 20-20 vision.

5. There was also some evidence that accuracy was independent of definite awareness of reversals.

6. There were some doubtful indications, which should be investigated further, of a possible relation between detection of left-right reversals and age of subject.

7. The provisional interpretation for the limited data is that spatial orientations of the types investigated play no necessary role in the young child's identifications of plane visual forms. This interpretation evidently favors the Gestalt position. But more work with younger children and other appropriate controls might well disclose a genetic development.

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A NEW EIDETIC PHENOMENON

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Despite the fund of eidetic literature that is at hand to date, it has failed to enlist any widespread and active interest among American psychologists. Belonging, as it does, to the category of special abilities, eidetic imagery has been relegated to a remote corner of research.

However, the eidetic field is fertile with theoretical implications and experimental possibilities which should not be overlooked. The basic facts that the eidetic image is externalized or "seen" with apparently perceptual objectivity, and that under certain conditions it "obeys" or is psychologically modified by certain laws of optics, by the physiological conditions of the retina, and by the spatial position and lability of the screen open up avenues of approach for the investigation of dynamic visual processes as well as for methods of determining the precise nature of the eidetic image itself. The latter problem beckons our immediate interest, in view of the important bearing it must have upon fundamental psychological theory. What, then, is the mechanism of the eidetic image?

In a preliminary attack upon this problem, we have uncovered what seems to be a new and significant phenomenon, namely, that an eidetic image can be inverted phenomenally by rotating the screen 180 degrees. This fact suggested the presentation of inverted pictures, for which eidetic images were obtained. Rotation of the screen righted the images for the Ss. The latter variation of the rotation phenomenon brought out the fact that, although the Ss were unable to interpret the visually presented inverted pictures, the perceptual meaning dawned in the eidetic phase after the eidetic images had been projected and after the screen had been rotated 180 degrees.

To test this phenomenon more rigidly, a complicated picture was used. A magazine advertisement was presented in inverted position to several adults, none of whom succeeded in perceiving what it was. Upon rotation of the picture, the variegated mass of daubs and streaks was easily recognized as a birthday cake. This inverted picture was used in succeeding rotation experiments with eidetic boys, and in every case the meaning of the picture became clear only in the eidetic phase, after the screen had been rotated 180 degrees. It is also curious to note that a large card with the word "FRIGIDAIRE" boldly printed thereon was presented visually in inverted position to a nine year old eidetic boy. An inverted eidetic image was obtained, but it could not be interpreted. Upon rotation of the screen, the boy recognized the image as a word which he could not pronounce but which he promptly spelled out. He reported that one letter, "G," had faded out, so that he could not perceive what it was.

Have we here a phenomenon of pure suggestion? An effort was made to control suggestion by verbal counter-suggestion, but the eidetic image clung faithfully to the projection screen. With a stationary screen, the Ss could rotate their

[1] From The Catholic University of America.

images slightly, but all rotations were below 90 degrees. More rigid investigations to determine the suggestion factor are now in progress.

This phenomenon is important not only for eidetic research; it also offers a promising device for investigating Gestalt aspects of perception.

PERSONALITY CHARACTERISTICS OF JUVENILE DELINQUENTS
I. A METHOD FOR THE SELECTION OF DIFFERENTIATING TRAITS

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INTRODUCTION

Scientifically controlled studies have revealed a number of differential factors in the personality of juvenile delinquents. While it is too early to assume that certain factors are peculiarly distinctive, it is evident that on a comparative basis delinquents manifest characteristics which distinguish them from the socially adjusted. Bryant (2) has called attention to a reliable difference between delinquents and non-delinquents in "will-temperament." Bridges and Bridges (1), by means of the Pressey X-O technique, found that delinquent boys as a group consider fewer things wrong but have more worries than normal boys. This conclusion is supported by Courthial (3) in an investigation of delinquent girls. Slawson (5) and Courthial (3) have discovered striking differences in emotional stability between delinquents and non-delinquents. According to these investigators, both boy and girl delinquents exhibit a greater number of neurotic traits than do control groups. Smith (6) has pointed out that delinquents display more of a tendency toward feelings of inferiority than non-delinquents.

Constitutionally then it appears that the personality of delinquents differs in several interesting and significant respects from the personality of normally adjusted individuals. Further exploring, however, may well be done. Stated generally, the purpose of the present study is an attempt to answer in a limited manner the question: Are there qualities or traits which are definitely related to the personality of juvenile delinquents?

PROBLEM AND METHOD

A technique devised by Pressey (4), the Interest-Attitude Tests, was used as a basis for the succeeding analysis. This instrument consists of four parts or tests, each containing 90 items. The subject is instructed to respond discriminatingly to words suggesting things considered wrong (Test I); anxieties, fears, or worries (Test II); likes and interests (Test III); and kinds of people liked or admired (Test IV). Norms are available for the separate tests by sex and grade (sixth grade to fourth year college) in terms of number of responses to each item per 100 cases, hereinafter designated _times-in-100_.[2]

Employing the Pressey norms for comparative purposes, an effort was made to ascertain those items from each test which, in varying degrees, differentiated delinquents from non-delinquents. This involved an analysis of the frequency

[1] From Ohio State University.

[2] From Test I the first five items are _accidents_, _fighting_, _ignorance_, _talking back_, _and crying_. The subject is instructed to indicate by a cross (X) everything which is regarded as _wrong_, and by a double cross (XX) everything considered _very wrong_. Thus if a given item were single-crossed by 35 and double-crossed by 20 subjects out of a group of 60, the total number of responses would be 75 and the number of responses per 100 cases would be 125.

CHILD DEVELOPMENT, Vol. 8, No. 2 (June, 1937)

with which responses to each item were made by the delinquent group and reduction of resulting frequencies to times-in-100. Essentially speaking, the problem was one of finding, on the basis of comparative frequency with which delinquents and non-delinquents respond to the various items, those responses which most clearly typify juvenile delinquents.

For the investigation the cases of 316 boys from an institution for juvenile delinquents were available. All subjects were of the white race. Life ages ranged from 14 years, 0 months to 17 years, 11 months. No other forms of selection were attempted. The group constituted apparently a fairly representative sample of delinquent boys in general.

Since item norms for the *Interest-Attitude Tests* are stated in terms of grade level, the 316 delinquent cases were subdivided into four groups according to life age for purposes of comparing the responses of delinquents with norms for non-delinquents approximately age for age. It was assumed that the median life ages for grades 8, 9, 10, and 11 were equivalent to the conventional age-grade standards, i.e., 14, 15, 16, and 17 years of age, respectively. In fact Pressey found the median life ages of boys on whom norms were established to be 13.9, 15.0, 16.0, and 16.8 for the grades in question. Hence, the experimental group (delinquents) were subdivided similarly as follows: 66 cases in the 14-year group; 75 cases in the 15-year group; 112 cases in the 16-year group; and 63 cases in the 17-year group.

Discrepancies between the medians for the foregoing four life age groupings and the median life ages obtained by Pressey for the boys in each of the four grades, 8, 9, 10, and 11 were without significance.[3]

Criteria for selection of differential items were established by a series of steps illustrated from the following tabular arrangement:

TABLE 1

TECHNIQUE OF ITEM ANALYSIS FOR INTEREST-ATTITUDE TESTS

Item No.	Frequency	Times-in-100 (Delinquent)	Times-in-100 (Normal)	Dv.
1	48	73	51	+22
20	46	70	96	-26
39	27	41	36	+ 5
43	72	109	116	- 7
60	65	98	117	-19

Table 1 shows the form of analysis used, illustrated by five items from Test I (things considered wrong). The items, according to numbers entered in the first column, are accidents, bribery, disagreement, pool rooms, and bullying. Illustrative data are based on the 14-year group. The table is interpreted as

[3] Median life ages for each grade on which the Interest-Attitude Tests were standardized are reported for both sexes by S.L. and L.C. Pressey in a manual, including directions for administering the tests, instructions for scoring, and complete norms. Published by The Psychological Corporation, New York, N.Y.

follows: 66 delinquent boys of the 14-year group considered item 1 (accidents) wrong 48 times, which means that 14-year delinquents responded to the item 73 times-in-100. Compared to this the norms indicate that the control group (grade 8, equivalent to 14-year non-delinquent boys) responded to the same item 51 times-in-100. The difference in response is thus 22 times more for delinquents than non-delinquents. This value is recorded in the column headed Dv., meaning deviation. When times-in-100 was greater for delinquents than non-delinquents the deviation for the particular item was given a plus sign. When the converse was true the deviation was identified by a minus sign. An inspection of deviations in Table 1 reveals that in the case of items 1 and 39 delinquents responded proportionately a greater number of times than the control group; to items 20, 43, and 60, non-delinquents exceeded the experimental group as to times-in-100. Computations similar to those shown in Table 1 were made for the 90 items comprising each of the four tests. Each age group was treated separately for each test. Thus, there were four arrays of deviations for Test I; four for Test II; and the same number each for Tests III and IV.

As a further step in the development of criteria four ogives were constructed, one for each test, based on the total number of deviations for the four age groups, each ogive incorporating 360 deviations. On each ogive the 75th percentile point, for the particular array of deviations in question, was located. Since the purpose of the plus and minus signs was to indicate direction of deviations these denotations were disregarded in constructing the ogives. Thus, the first criterion for selecting differential items was ascertained, namely, to be regarded as basically significant the magnitude of deviation of an item must equal or exceed the value for the 75th percentile of the array of deviations in question.[4] To illustrate: the 75th percentile for 360 deviations based on the results of Test I is 19. In Table 1 is an array of five sample deviations from Test I, 14-year group. Applying the criterion heretofore expressed, items 1, 20, and 60 are fundamentally significant because each equals or exceeds 19.

Following the same procedure, differential items were selected from each of the four arrays of deviations, i.e., by life age groups, for each of the four tests. The value for the 75th percentile in terms of 360 deviations in Test II was found to be 25; for Test III 31; and for Test IV 29.

Application of the first criterion led logically to a second criterion. As the deviations for each age group in relation to each given test were analyzed for differential items, it became evident that there was considerable variability both in the type of item which was significant from age to age and consistency with which certain items were differential from one age group to another. Hence, a second criterion developed: in proportion to whether or not an item was differential for one, two, three, or four age levels it was considered as more or

[4] Some question may be raised as to the reason for adopting the 75th percentile point in each series of deviations as the value which the deviation of each item must equal or exceed in order to be regarded as differential. In establishing such a point the investigator was faced with two possibilities. First, an entirely arbitrary value could have been selected. Second, a value could be found which was an expression of the quantitative tendencies of the data themselves. The latter procedure was employed and the value of the 75th percentile set as the point of origin. It was assumed that so far as the operation of this one criterion is concerned items would become more and more sensitive in differentiating control and experimental groups in proportion as the value-point was moved away from modal deviations.

less significant.

Growing out of the first and second criteria was a third criterion on the basis of which to judge the effectiveness of an item in differentiating between delinquents and non-delinquents. This third standard may be illustrated as follows: from Table 1 it will be noted that item 1 exceeds the 75th percentile of 19 by 3 points; item 20 by 7; and item 60 is exactly at 0. Items 39 and 43 are not regarded as differential, each being less than the 75th percentile with which it is compared. It would appear, therefore, that item 20 is the most significant of the five items listed. Conventionally stated, therefore, the third criterion is: an item is more or less effective in proportion to the magnitude of its difference from the value of the 75th percentile.

The last principle has been applied along with the two criteria previously described. The operation of the three criteria in selection of differential items will be more thoroughly clarified in the subsequent analysis.

STATISTICAL ANALYSIS

Employing the three criteria, Table 2 was constructed, showing differential items from Test I according to age level.

TABLE 2

DIFFERENTIAL ITEMS BY AGE GROUP FROM TEST I (THINGS CONSIDERED WRONG), BASED ON THREE CRITERIA *

		14-year group			
accidents	+ 3,I	poker	- 1,I	outcast	+ 2,III
atheist	0,IV	tobacco	-23,I	bullying	0,IV
having a temper	- 1,I	being conceited	-20,IV	playing cards	+ 4,IV
smoking	-15,I	spitting	-21,II	playing hockey	- 4,I
bribery	- 7,IV	betting	-23,I	being a snob	- 4,II
being a cad	- 3,II	gang	+26,IV	yellowness	- 3,I
		15-year group			
atheist	0,IV	petting	0,I	noisiness	+10,I
pawning jewelry	0,I	being conceited	-13,IV	bullying	- 7,IV
carrying a revolver	+21,III	spitting	- 1,II	playing cards	+ 5,IV
insanity	+ 4,II	gang	+24,IV	punishment	0,I
anger	+19,III	prison	+ 3,III	shouting	+ 2,II
bribery	-32,IV	outcast	+ 6,III	lawlessness	- 7,II
		16-year group			
speeding	+ 3,II	anger	+ 7,III	gang	+27,IV
atheist	- 7,IV	bribery	-15,IV	prison	+13,III
carrying a revolver	+48,III	arguing	+ 6,II	bullying	- 6,IV
teasing someone	+ 1,II	freak	+ 4,II	playing cards	+17,IV
insanity	+ 3,II	being conceited	-32,IV	using slang	+ 2,II

*In Tables 2 to 9 the Arabic notation after an item indicates the magnitude of difference between the deviation of the item in question and the 75th percentile; a positive or negative sign shows direction of the original deviation; the Roman notation signifies the number of age levels with respect to which a given item equals or exceeds the 75th percentile.

TABLE 2 – Continued

17-year group

fighting	+18,I	arguing	+37,II	divorce	+ 9,I
speeding	+ 8,II	being a cad	0,II	playing hookey	+13,I
atheist	- 7,IV	freak	+ 4,II	suspicion	+ 9,I
carrying a revolver	+63,III	being conceited	-39,IV	slickness	+12,I
teasing someone	+ 6,II	gang	+51,IV	shouting	0,II
smoking	+ 2,I	prison	+14,III	using slang	+ 5,II
anger	+ 5,III	outcast	+ 5,III	lawlessness	-18,II
bribery	-10,IV	toughness	0,I	war	+ 1,I
peddling	+ 8,I	bullying	- 2,IV	being a snob	-23,II
		playing cards	+34,IV		

Table 2 is interpreted as follows: atheist listed in the items of the 14-year group has an Arabic notation of 0, meaning that its deviation was exactly 19 for the 14-year age level. The Roman notation IV shows that the deviation for this paticular item equalled or exceeded the 75-percentile likewise for the 15, 16, and 17-year groups. By contrast, the item tobacco, although its deviation exceeded the 75-percentile by 23, is found to be differential only at the 14-year level (see Roman notation).

The three criteria were applied to test II. Differential items were ascertained for each age level. These are set forth in Table 3.

TABLE 3

DIFFERENTIAL ITEMS BY AGE GROUP FROM TEST II (WORRIES, FEARS, ANXIETIES), BASED ON THREE CRITERIA

14-year group

suffering	+ 9,III	death	+16,IV	ache	0,I
collision	- 2,I	storms	+ 1,I	disease	+ 5,I
poison	+ 6,III	burglars	+ 1,I	flames	+ 2,I
choking	+ 1,II	gun	+15,II	thieves	+ 3,I
pain	0,IV	floods	+ 8,I	dying	+ 9,IV
hold-ups	0,II	homeliness	0,II	falling	0,I
knives	+ 5,I	family	+ 8,IV	funeral	+18,IV
rackets	+ 6,I	danger	+ 6,III	robbers	+ 9,II
grave	+ 1,III	jail	+13,IV	sickness	+ 7,II
suffocating	+ 3,I	sins	+15,IV	operation	+ 6,II
tuberculosis	+ 6,II			wrecks	+14,III

15-year group

suffering	+ 6,III	death	+15,IV	dreams	0,I
detective	+ 7,II	crimes	+ 1,II	sins	+ 7,IV
murder	+10,III	being hurt	+ 7,I	dying	+23,IV
poison	+12,III	being unlucky	+ 9,I	funeral	+ 2,IV
fainting	+ 6,I	homeliness	+10,II	sickness	+ 8,II
smothering	0,I	family	+37,IV	operation	+ 4,II
pain	+ 7,IV	craziness	+ 3,I	wrecks	+ 4,III
grave	+ 8,III	jail	+17,IV	work	+ 3,I

16-year group

suffering	+15,III	tuberculosis	0,II	jail	+25,IV
murder	+11,III	death	+21,IV	sins	+16,IV
poison	+ 2,III	family	+13,IV	dying	+18,IV
pain	+ 1,IV	danger	0,III	funeral	0,IV
grave	+ 8,III			wrecks	+ 1,III

TABLE 3 - Continued

17-year group

detective	+11,II	enemies	+ 3,I	jail	+30,IV
murder	+ 9,III	death	+22,IV	sins	+ 7,IV
cheating	+ 4,I	crimes	+ 7,II	smoking	+ 2,I
choking	+ 3,II	examinations	-15,I	dying	+ 8,IV
pain	+11,IV	gun	+ 5,II	funeral	+ 6,IV
hold-ups	+ 6,II	family	+24,IV	robbers	+ 4,II
		danger	+ 1,III		

Table 3 is interpreted in a similar manner to Table 2. It is obvious from an inspection of the table that items are significant for a varying number of age levels. For example, as revealed by Roman notations, rackets occurs only at the 14-year level; hold-ups occurs in two age groups, 14-year and 17-year; grave appears in the 14, 15, and 16-year groups; and death is found in all age groups from 14-year to 17-year.

Based on criteria described heretofore Table 4 shows differential items by age groupings from Test III.

TABLE 4

DIFFERENTIAL ITEMS BY AGE GROUP FROM TEST III (LIKES AND INTERESTS), BASED ON THREE CRITERIA

14-year group

drawing	+ 6,I	animal trainer	+25,II	history stories	+21,I
movie star	+34,IV	doctors	0,I	picture puzzles	+12,I
soldiers	+17,I	auto driving	+ 3,II	parties	+ 3,II
actors	+ 5,I	sailors	+20,II	story writing	+ 5,I
clubs	+16,II	exploring	+ 1,I	tap dancing	+ 6,III
magazines	+22,II	locomotive engineer	+ 2,I	Red Cross work	+16,II
joyriding	+15,III	art galleries	+ 2,I	candy	+29,II
soda clerk	+ 6,II	church	+23,IV	swinging	+13,II
rancher	0,I	reading	+12,I	geography games	+14,I
circus	+34,IV	children	+ 5,I	mountains	+ 5,I
bicycling	+14,I	studying	+16,I	whistling	+ 1,I
		coffee	+21,III		

15-year group

movie star	+25,IV	circus	+20,IV	cards	+ 6,II
comedies	+ 2,I	animal trainer	+ 4,II	cowboy	+13,II
clothes	+10,II	card parties	+10,I	parties	+15,II
beaches	+ 9,I	auto driving	+18,II	tap dancing	+20,III
clubs	0,II	chewing gum	+ 8,I	Red Cross work	+ 4,II
magazines	+ 2,II	prizes	+ 4,I	candy	+26,II
joyriding	+21,III	church	+23,IV	swinging	+ 2,II
ice-cream man	+ 9,I	fancy dancing	+ 6,III	acrobats	+ 4,II
soda clerk	+ 1,II			shooting	+11,I

16-year group

movie star	+ 9,IV	hunting	+ 5,II	cards	+ 4,II
joyriding	+ 4,III	church	+13,IV	cowboy	+12,II
circus	+ 9,IV	fancy dancing	+ 7,III	tap dancing	+ 6,III
poker	+ 6,I	coffee	+ 8,III	acrobats	0,II

17-year group

movie star	+ 3,IV	baseball	+14,I	baseball players	+22,I
clothes	+10,II	sailors	+ 2,II	church	+13,IV
college	- 5,I	hunting	+17,II	fancy dancing	0,III
circus	+ 2,IV			coffee	+ 4,III

Interpreted in the same way as Tables 2 and 3 items from Test III, as listed in Table 4, are seen to vary in differential significance from one to four age levels. For instance, of the likes and interests, movie star is present at all age levels, whereas doctors occurs only in one age group.

Analysis of Test IV resulted in the differential items listed in Table 5, shown according to age group.

TABLE 5

DIFFERENTIAL ITEMS BY AGE GROUP FROM TEST IV (KINDS OF PEOPLE LIKED OR ADMIRED), BASED ON THREE CRITERIA

14-year group

alert	-11,III	quick	+ 4,IV	busy	+ 5,I
cooperative	-14,IV	wealthy	+14,IV	joyful	+ 2,III
reliable	-10,II	well-dressed	+ 9,III	quiet	+ 5,III
capable	-10,I	loving	+24,I	sharp	0,II
lovely	+22,II	careful	+13,II	handsome	+32,IV
husky	+22,III	good-looking	+29,III	gentle	+ 3,II
brave	+ 7,IV	rich	+23,III	hopeful	+13,II
incentive	+ 4,I	up-to-date	+ 5,II	fair	+11,II
		humorous	- 6,III		

15-year group

talented	- 5,II	able	+ 1,I	up-to-date	+ 6,II
cooperative	- 6,IV	quick	+19,IV	joyful	+ 7,III
progressive	- 8,II	wealthy	+19,IV	quiet	+17,III
lovely	+ 4,II	well-dressed	+29,III	sharp	0,II
husky	+13,III	diligent	0,I	handsome	+14,IV
lively	+ 8,II	careful	+ 6,II	gentle	+ 6,II
easy-going	+ 2,I	peppy	+ 5,I	hopeful	+ 4,II
brave	+ 8,IV	good-looking	+17,III	fair	+13.II
		rich	+ 6,III		

16-year group

alert	- 1,III	brave	+ 3,IV	original	- 4,II
cooperative	- 4,IV	quick	+13,IV	humorous	- 3,III
husky	+23,III	wealthy	+ 2,IV	quiet	0,III
lively	+ 7,II	good-looking	+ 2,III	handsome	+ 8,IV
		rich	+ 6,III		

17-year group

alert	-18,III	broad-minded	-20,I	peaceful	0,I
courageous	- 9,I	sociable	- 3,I	economical	-14,I
talented	- 8,II	brave	+ 6,IV	original	-10,II
cooperative	-15,IV	quick	+ 8,IV	humorous	-20,III
progressive	-11,II	wealthy	+ 4,IV	witty	-16,I
reliable	-15,II	well-dressed	+ 8,III	joyful	+ 1,III
efficient	-11,I	amiable	- 6,I	handsome	+11,IV
having initiative	- 7,I	sincere	-11,I	punctual	- 1,I
optimistic	- 1,I			enthusiastic	- 2,I

As indicated previously certain items in the separate tests are shown to be significant for only one age level, others for two or more age groups. In Test IV the situation is no different, as is clear from Table 5. As a case in point, handsome appears in all age groups; quiet in three; up-to-date in two; and capable in only one.

Tables 2, 3, 4, and 5 provide all of the basic information necessary to a more extended analysis of the Interest-Attitude Tests. The major problem, in the light of the three criteria, consisted in selecting from the four arrays of differential

items those which from each test were of greatest significance in the personality of juvenile delinquents. To do this the following procedure was adopted: items which from any given test appeared in all four age groups were listed separately, together with the extent of difference of each deviation from the 75-percentile; items appearing at three age levels were similarly listed; and likewise items found in two and one age groups. For example, an inspection of Table 2 shows that from Test I atheist is found in age groups 14, 15, 16, and 17 with differences from the 75th percentile of 0, 0, -7, -7, respectively; carrying a revolver appears in three age groups with differences of +21, +48, and +63 from the 75-percentile; speeding is found in two age groups with differences of +3 and +8; and accidents appears at only one age level with a difference from the 75-percentile of +5. In all cases in which an item appeared in two, three, or four age groups its mean difference from the 75th percentile was computed. The mean was employed because it seemed to be that specific value for the particular item which indicates on the average its discriminative significance for the age groups in which it is found.

Table 2 shows that six items were differential for four age levels,[5] atheist -3.5, bribery -16.0, being conceited -26.0, gang +32.0, bullying -3.8, and playing cards +15.0. Four items appear in three age groups, carrying a revolver +44.0, anger +10.3, prison +10.0, and outcast +4.3. Eleven items were differential for two age levels and twenty-one differentiated for only one age group.

It will be recalled that the basic lists of items from each test, shown in Tables 2 to 5, were compiled in terms of the fact that magnitudes of deviations of certain items equalled or exceeded the value of the 75-percentile of the array of deviations in question. The operation of this criterion was fundamental to the application of the other two. As a result of applying the last two criteria it was ascertained that (a) items were significant for varying numbers of age levels from one to four, and (b) individual items, irrespective of the number of age groups in which found, varied as to the extent of their differences from the 75-percentile. Conclusions suggested thus far, therefore, from analysis of items in the basic lists (Tables 2 to 5) are: first, particular items are significant in proportion to the number of age levels in which they occur; and second, particular items are significant in terms of the extent of difference from the 75-percentile.

By the application of successive criteria it was possible to select items which best differentiated juvenile delinquents, and rank such items in the order of their significance. The mean differences from the 75-percentile having been computed for items appearing in two, three, or four age groups, an arbitrary point of origin was fixed which such mean differences must equal or exceed. It was assumed that means must equal or exceed 10 in order to be included among the most differential items. Items which were found in only one age group, but the differences of which from the 75th percentile equalled or exceeded 10, were included in the list of most significant items, their differential value, of course, being limited by the fact of appearing in only one age group. The higher or lower ranking of an item was first of all governed by the number of age groups in

[5] Numbers after each item indicate the mean difference of its deviation from the 75-percentile: signs show the direction of original deviations.

which it appeared, second by its mean difference from the 75th percentile. Items appearing in four age groups were first in order, ranked subsequently in terms of the magnitude of their mean differences. Items appearing in three age groups were next in order with items appearing in two and one age groups following. Hence, if the mean difference of an item was +15 based on appearance in four age groups it was regarded as having greater ranking significance than one with the same or greater mean value based on appearance in three or fewer age groups.

In Tables 6, 7, 8, and 9 are listed items from each of the four Interest-Attitude Tests which have been ascertained as most differential for juvenile delinquents.

TABLE 6

SIGNIFICANT ITEMS FROM TEST I (THINGS CONSIDERED WRONG)

gang	+32, IV	prison	+10, III	betting	-23, I
being conceited	-26, IV	arguing	+22, II	fighting	+18, I
bribery	-18, IV	being a snob	-14, II	smoking	-15, I
playing cards	+15, IV	lawlessness	-13, II	playing hookey	+13, I
carrying a revolver	+44, III	spitting	-11, II	slickness	+12, I
anger	+10, III	tobacco	-23, I	noisiness	+10, I

Of 42 separate items from Test I contained in the basic list of Table 2, eighteen or 43 per cent appear to be markedly differential according to assumptions explained in this study. That the importance of items seems to be related somewhat to the number of age groups in which they are found is suggested by the following:

of 6 items in 4 age groups, 4 are significant = 67 per cent;
of 4 items in 3 age groups, 3 are significant = 75 per cent;
of 11 items in 2 age groups 4 are significant = 36 per cent;
and of 21 items in 1 age group 7 are significant = 33 per cent.

TABLE 7

SIGNIFICANT ITEMS FROM TEST II (WORRIES, FEARS, ANXIETIES)

jail	+21, IV	dying	+15, IV	suffering	+10, III
family	+21, IV	sins	+11, IV	gun	+10, II
death	+19, IV	murder	+10, III	examinations	-15, I

From Test II 46 separate items are listed in Table 3, of which 9 or 20 per cent are significant. The relationship between number of age levels in which items appear and their significance again appears to be substantiated by the following:

of 7 items in 4 age levels, 5 are significant = 71 per cent;
of 6 items in 3 age levels, 2 are significant = 33 per cent;
of 10 items in 2 age levels, 1 is significant = 10 per cent;
and of 23 items in 1 age level, 1 is significant = 4 per cent.

TABLE 8

SIGNIFICANT ITEMS FROM TEST III (LIKES AND INTERESTS)

circus	+18,IV	magazines	+12,II	soldiers	+17,I
movie star	+18,IV	sailors	+11,II	studying	+16,I
church	+18,IV	hunting	+11,II	bicycling	+14,I
joyriding	+13,III	auto driving	+11,II	geography games	+14,I
coffee	+11,III	Red Cross work	+10,II	baseball	+14,I
tap dancing	+11,III	clothes	+10,II	picture puzzles	+12,I
candy	+28,II	baseball player	+22,I	reading	+12,I
animal trainer	+15,II	history stories	+21,I	shooting	+11,I
cowboy	+13,II			card parties	+10,I

Table 4 contains 51 basic items from Test III. Table 8 reveals that 26 or 51 per cent of these are significant. The following is of interest in support of relationships already mentioned:

of 3 items in 4 age levels, 3 are significant = 100 per cent;
of 4 items in 3 age levels, 3 are significant = 75 per cent;
of 15 items in 2 age levels, 9 are significant = 60 per cent;
and of 29 items in 1 age level, 11 are significant = 38 per cent.

TABLE 9

SIGNIFICANT ITEMS FROM TEST IV (KINDS OF PEOPLE LIKED OR ADMIRED)

handsome	+16,IV	rich	+12,III	broad-minded	-29,I
quick	+11,IV	alert	+10,III	loving	+24,I
wealthy	+10,IV	lovely	+13,II	witty	-16,I
cooperative	-10,IV	reliable	+13,II	economical	-14,I
husky	+19,III	fair	+12,II	efficient	-11,I
good-looking	+16,III	progressive	-10,II	sincere	-11,I
well-dressed	+15,III	careful	+10,II	capable	-10,I

In Table 9 are listed 21 items, or 46 per cent, ascertained as significant from 46 items contained in Table 5, the basic list from Test IV. The following indicates relationships between number of age levels in which an item appears and its significance:

of 5 items in 4 age levels, 4 are significant = 80 per cent;
of 8 items in 3 age levels, 5 are significant = 62 per cent;
of 12 items in 2 age levels, 5 are significant = 42 per cent;
and of 21 items in 1 age level, 7 are significant = 33 per cent.

CONSISTENCY OF THE DIFFERENTIATING TRAITS

As a means of establishing consistency of the procedures adopted for selecting items most differential for juvenile delinquents, a further form of analysis was undertaken. It may be described as follows: first, the mean times-in-100 response was made to each item by control subjects from grades 8, 9, 10, and 11 was computed; second, the frequency with which all four age groups of delinquent boys

responded to each item was ascertained, these values in turn being reduced to *times-in-100*; third, the same item-by-item comparisons were made in this last instance as has been discussed heretofore. That is, an attempt was made to determine whether or not by treating the control and experimental groups without regard to life age approximately the same items would emerge to distinguish delinquents from non-delinquents as have been found previously. Thus, four series of deviations resulted. The 75-percentile was again ascertained for each series of deviations by means of ogives. From each test the number of items which equalled or exceeded the respective numerical values of the 75-percentile were as follows:[6]

Test I: 14 plus items; 6 minus items;
Test II: 21 plus items; 0 minus items;
Test III: 20 plus items; 0 minus items;
Test IV: 15 plus items; 6 minus items.

Items selected as being most significant were those exceeding the 75th percentile by ten or more points.

Table 10 shows for each test, in terms of a comparison of the total control and experimental groups, items which exceed by 10 or more points the 75-percentile of the array of deviations in question. As in previous connections plus and minus signs denote the direction of deviations.

In comparing the total control and experimental groups the greater or less effectiveness of an item in differentiating delinquents from non-delinquents was judged finally by the amount of its excess over the value of the 75th percentile involved. By this method it was possible to assign a crude ranking to the items selected. As shown in Table 10, when total groups were compared, seven items from Test I emerged that were ten or more points above the value of the 75th percentile. These are shown in rank order in the column headed Rank A. The item carrying a revolver exceeded the 75-percentile by 36 points and so is assigned first ranking in the A series. Other selections and rankings of items were made in an identical manner.

The problem of selecting a final list of items that best differentiate between delinquent and non-delinquent subjects is embodied in the question: To what extent are the most significant items selected according to the first set of assumptions, i.e., the three criteria described earlier in this study related to those items ascertained by the last method of analysis? A simple device was employed for determining the relationship. A glance at Table 6 will reveal that the seven most significant items in rank order from Test I, selected by the three criteria, are gang, being conceited, bribery, playing cards, carrying a revolver, anger, and prison. That is, gang is ranked 1, being conceited 2, and so on to prison, receiving a rank of 7. For comparative purposes the column headed Rank B is used in Table 10 to show the foregoing rankings. Thus, carrying a revolver is ranked 1 in the A series and 5 in the B series; gang is ranked 2 in the A series and 1 in the B series; and similarly for the other items. A discrepancy should be

[6] Values of the 75-percentile for each of the four latter series of deviations are: Test I, 15; Test II, 22; Test III, 29; Test IV, 27.

TABLE 10

SIGNIFICANT ITEMS IN TERMS OF TOTAL GROUPS

Item	Excess over 75 percentile	Rank A	Rank B
	Test I (things considered wrong)		
carrying a revolver	+36	1	5
gang	+35	2	1
being conceited	-31	3	2
being a snob	-22	4	9
playing cards	+18	5	4
bribery	-17	6	3
prison	+11	7	7
	Test II (worries, fears, anxieties)		
jail	+24	1	1
family	+23	2	2
death	+20	3	3
dying	+17	4	4
sins	+15	5	5
	Test III (likes and interests)		
church	+24	1	3
circus	+18	2	1
movie star	+18	3	2
tap dancing	+11	4	8
joyriding	+10	5	4
candy	+10	6	7
	Test IV (kinds of people liked or admired)		
handsome	+17	1	1
husky	+17	2	5
quick	+12	3	2
well-dressed	+12	4	7
wealthy	+11	5	3
good-looking	+11	6	6
cooperative	-11	7	4
rich	+10	8	8

noted: being a snob does not appear among the first seven items in Table 6, but is ninth in rank. It has been so indicated in the B series of Table 10. Further anger appears as the sixth ranking item in Table 6 but is not among the seven from Test I in Table 10. Aside from these exceptions the highest ranking items from Test I as set forth in Table 6 are identical with those listed in Table 10. The same comparisons were drawn for Tests II, III, and IV, employing Tables 7, 8, and 9, respectively, for assigning ranks in series B of Table 10. In only one other instance was there lack of identity between the A and B series of items in Table 10. Table 8 shows that coffee is the fifth ranking item from Test III. This item does not appear among the six items from this test listed in Table 10. The item candy is ranked 7 in Table 8, this being the placement assigned in the B series of Table 10.

As a means of comparing the A and B series of Table 10 the term mean displacement has been utilized. This device shows merely how closely the rank order of items in one series follows the rank order of the other. If the differences in

ranks for items from Test I are computed and these averaged, the mean displacement is found to be 2.1; for items from Test II the mean displacement is 0; for items from Test III, 1.3; and Test IV, 1.5. With only minor exceptions it appears that the items listed in Table 10 from the four Interest-Attitude Tests are the most sensitive in differentiating between delinquents and non-delinquents. This fact is established by two dissimilar methods of analysis. The method of selecting items by three criteria is likely the more adequate of the two because it introduces a greater degree of statistical refinement. It is interesting to note, however, that irrespective of the method of selection the items found to be most differential are markedly similar.

DISCUSSION AND SUMMARY

While in this investigation chief emphasis has been placed on methodology, a not unimportant query might well be raised as to what fundamental dispositions are revealed in the personality of juvenile offenders by items which effectively differentiate them from normally adjusted individuals. If not only the items of Table 10 but direction which certain responses have taken are interpreted broadly a few generalizations appear to be warranted. First, of things considered wrong undesirable social traits, such as being conceited and being a snob are of negative concern to juvenile delinquents. Second, a pronounced morbid strain seems to characterize delinquents as indicated by their positive emphasis on items of worry or anxiety, such as death, dying, and sins. Third, likes and interests of juvenile offenders are mostly of a superficial or relatively evanescent nature as shown by their pronounced stressing of circus, movie star, tap dancing, joy riding, and candy. Fourth, reactions to kinds of people admired suggest the essentially egocentric character of juvenile delinquents. Items, such as handsome, husky, well-dressed, wealthy, good-looking, and others of a similar sort, are positively viewed while, interesting to note, cooperative receives negative emphasis. The foregoing interpretation gives an imperfect picture of the personality of juvenile delinquents. A more incisive clinical analysis based at least in part on the items of Table 10 would undoubtedly enlarge present understanding of the personality of juvenile offenders.

The most important aspects of this investigation of personality characteristics of juvenile offenders may be summarized briefly. A method has been proposed by means of which items from the Pressey Interest-Attitude Tests may be selected that are differential for delinquent as compared with non-delinquent subjects. The fundamental principal employed implies the operation of three criteria for selecting significant items. Consistency of the basic method is checked by employing a second dissimilar procedure.

By applying successive criteria three facts were ascertained: (a) basic lists of items from each test that are significant; (b) items that are differential for four, three, two, and one age groups; and (c) items which are maximally effective in differentiating delinquents from non-delinquents. It is clear that juvenile offenders differ from non-offenders rather generally in characteristics, such as things considered wrong; worries, fears, and anxieties; likes and interests; and kinds of people liked or admired. More important still is the fact that within those categories certain items are unusually sensitive in showing differences in

the groups studied. If cues provided as a result of the present analysis are indicative, *the conclusion* is inescapable that delinquents are constitutionally different from normally adjusted individuals.

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DEFICIENCIES IN AMPLITUDE OF JOINT MOVEMENT ASSOCIATED WITH MENTAL DEFICIENCY [1]

A. DOUGLAS GLANVILLE AND GEORGE KREEZER

I. INTRODUCTION

There is considerable evidence that the deficiencies of the mentally deficient are not limited to psychological functions alone, but may extend to other bodily functions and properties.[2] (1,4,8,9). This fact suggests the need for investigations of the covariation that may occur between different traits of the mentally deficient in order to provide clues to the common factors which may underly retardations in development of different characteristics. Investigation of motor development in the mentally deficient should be of particular interest since the motor functions, like the psychological ones, depend on the operation of the nervous system, and so may be expected to provide indications of conditions in this system.

The present study is part of a more extensive investigation being made of the development of motor functions in the mentally deficient (5,6). It is concerned with one particular property of motor activities, namely, the amplitude of movements possible at the various joints of the body. Our problem specifically, was to compare the maximum amplitudes of voluntary and passive joint-movements in sample groups of mentally deficient and of mentally normal subjects.

Limitations in motor activity are quite commonly observed by those working with the mentally deficient. These limitations may show themselves in an increased awkwardness and a lesser freedom of movement, even though these may not be severe enough to justify inferences as to specific neurological lesions. Tredgold, for example, states, "In a considerable number of aments, movement is deficient in quantity .... The condition is most common in the severest grade but it is also seen in the imbecile and feeble-minded." (9, p. 103). This statement is apparently based on casual clinical observation and not on systematic investigation by means of standardized methods. Although investigations have been reported of some aspects of motor activity in the mentally deficient (8), we have not found reports of any previous work on amplitude of joint movement.

Systematic work on the amplitude of joint movement even among mentally normal individuals has not been very extensive. A survey and bibliography of this work has been given in another paper, in which we have dealt with the question of normative standards of joint-movement (3).

II. CONDITIONS OF THE INVESTIGATION

A. Subjects.

[1] From the Department of Research of The Training School at Vineland, New Jersey. We are indebted to Dr. Edgar A. Doll for helpful suggestions.

[2] The multiplicity of symptoms in the case of certain of the special clinical types, such as the mongolian and the cretin, provides striking illustration of this tendency.

The experimental group of the present study consisted of 10 mentally normal and 10 mentally deficient subjects, all male adults, and without indications in their habitual everyday activities of any motor disorder. All subjects were right handed, as determined on the basis of Lauterbach's inventory for the determination of handedness (7).

The mental ages of the mentally deficient subjects ranged from 9.0 to 9.9 years as measured by the Stanford-Binet Scale (1916 revision). Their daily schedules consisted of either a combination of school work and light manual work or light manual work alone. These subjects had all been diagnosed as mentally deficient by the clinical division of the Vineland Laboratory. None of them were of any special clinical type.[3] With respect to etiology, 5 of these subjects were designated as probably hereditary cases, and 5 as of unknown etiology.

Of the mentally normal subjects, 9 were employees of the institution (4 teachers in the school, 3 members of the laboratory staff, and 1 a cottage attendant) and 1 was engaged in private business. Intelligence tests were not given to these subjects: occupational status was considered an adequate indication that they were of average intelligence or greater.

The subjects were so selected that the height and weight levels of the two groups of subjects were about the same. In the mentally normal group the average height was 5 ft. 9 in., with a range from 5 ft. 4 in. to 6 ft. 1 in.; average weight was 143 pounds with a range from 120 to 172 pounds. In the mentally deficient group the average height was 5 ft. 6 in., with a range from 5 ft. 3 in. to 6 ft. 3 in.; the average weight was 143 pounds, with a range from 116 to 174 pounds. The average age of the mentally normal group was 28.2 years, with a range from 20 to 43 years; the average age of the mentally deficient group was 25.5, with a range from 18 to 46 years.

B. Measuring instrument.

Measurements at all joints were made with the same instrument, what we call a plumb-line goniometer. Its operation is based on the relative movement produced between a circular scale, fixed in position relative to the moving member, and a plumb line provided by a pendulum suspended from the center of the scale. If the angular position of the plumb-line on the scale is noted before and after a given joint movement, a measurement is obtained of the angle through which the joint moves. The instrument may be attached to any part of the body and a record thus obtained of amplitude of movement at an adjacent joint. Further details concerning this instrument are given in (3).

C. Procedure.

Twenty-four different movements were measured on each subject for both passive

3 The statement that the subjects were of no special clinical type means that they failed to show the special symptoms sometimes associated with mental deficiency and commonly used as a basis for the classification of the mentally deficient into various clinical types. Examples of such special clinical types are mongolism, hydrocephalus, microcephalus, the cerebral infantile palsies, and epileptic amentia. For details see Tredgold (9, pp. 204-292).

and voluntary movements, and, except for two head movements, on both left and right sides of the body. The movements measured are specified in Tables 1 and 2. The value taken as the amplitude of a given movement in each subject was the average of three successive measurements.

Except for movements of (1) lateral flexion of head; (2) abduction of humerus; (3) pronation and supination of forearm; (4) flexion, extension, abduction and adduction of hand; and (5) abduction of femur, the measurements were taken with the subject lying in a supine, or in a prone position on a thin mattress placed on a table. For movements numbered (1), (3), and (4), the subject sat up, and for those numbered (2) and (5) the subject lay extended on his side. For measurements of passive movements, the subject was instructed to relax and the examiner applied force at the same point and attempted to use the same maximum force with all subjects. For measurements of voluntary movements, the subject was instructed to exert maximum effort (for example, to bend the arm as far as he could) and to avoid assistive movements or changes of gross bodily position. One examiner, (GL) made all measurements. To minimize possible variations from subject to subject, a standard set of conditions was adopted for each movement, with respect to position of subject, initial position of part moved, place of attachment of the instrument and procedures used to avoid possibly simultaneous movements at adjacent joints. These conditions and other details of procedure are given in a previous paper (3). Subjects were examined only when in good general health and not fatigued by previous activities.

III. RESULTS

Tables 1 and 2 show, for voluntary and passive movement respectively, the arithmetic means of the amplitude of movement at various joints, the differences between the arithmetic means for the mentally normal and mentally deficient groups, and the associated statistics for indicating the significance of the differences.

Examination of the tables shows:

1. For the large majority of both voluntary and passive movements, the amplitude of movement is greater for the mentally normal group than for the mentally deficient group. Thus, in 89% (41 out of 46) of the voluntary movements, and in 93% (43 out of 46) of the passive movements, the average amplitude of movements in the mentally normal group is greater than that in the mentally deficient group.

2. The differences between the mentally normal and mentally deficient groups are statistically significant in terms of a t (ratio of difference to its estimated standard error) equal to or greater than 2.1, in 15 of the voluntary movements (33%), and 17 of the passive movements (36%). These movements are indicated by an asterisk in the table. In all except one of these movements (voluntary right lateral flexion of the head), the amplitude is greater for the mentally normal group. A value of t equal to 2.1 corresponds to a probability of .975 that a difference of the averages greater than zero and of the same sign will be found in future samples.

3. An additional fact that emerges from examination of the original data,

TABLE 1

COMPARISON OF MENTALLY NORMAL AND MENTALLY DEFICIENT GROUPS IN MAXIMUM AMPLITUDE OF VOLUNTARY JOINT MOVEMENTS. (MEASUREMENTS IN ANGULAR DEGREES).

Part Moved	Mov't	Side	Mentally Normal (N) Mean	Mentally Normal (N) S.D. Mean	Mentally Deficient (MD) Mean	Mentally Deficient (MD) S.D. Mean	Diff. of Means (N-MD)	S.D. Diff	$t = \frac{\text{Diff.}}{\text{S.D.}_{\text{diff}}}$
Head	Vent.Flex.		59.8	11.7	56.0	8.2	+ 3.8	4.5	.85
	Dors.Flex.		61.2	26.8	46.2	18.4	+16.0	10.2	1.47
	Lat.Flex.	*R	39.4	6.0	51.7	10.4	-12.3	3.8	3.23
		L	42.9	7.7	47.6	11.5	- 4.7	4.4	1.06
	Rotat.	R	77.2	16.1	69.1	15.2	+ 8.1	7.0	1.15
		L	79.8	12.8	73.4	13.8	+ 6.4	5.9	1.09
Upper Arm (at shoulder)	Flex. (forw.)	R	179.0	7.2	171.0	10.2	+ 8.0	3.9	2.05
		*L	179.0	6.3	171.0	11.4	+ 8.0	4.1	2.17
	Exten. (backw.)	R	55.2	10.1	54.5	13.3	+ 0.7	5.3	.13
		L	60.0	12.4	53.3	10.6	+ 6.7	5.1	1.31
	Abduct.	R	129.3	11.7	123.8	13.6	+ 5.5	5.7	.96
		L	130.3	11.2	130.3	13.2	0.0		
	Int.Rot.	*R	94.1	22.1	70.6	19.3	+23.5	9.3	2.52
		*L	100.0	18.3	75.1	14.1	+24.9	6.8	3.66
	Ext.Rot.	*R	82.7	10.0	55.5	21.2	+27.2	7.4	3.67
		*L	83.6	16.2	56.7	17.5	+26.8	7.5	3.57
Forearm (at elbow)	Flex.	*R	138.3	8.5	123.2	12.2	+15.1	4.7	3.21
		*L	144.3	8.9	123.7	11.8	+20.6	4.7	4.36
	Pronat.	R	91.1	25.8	82.4	31.4	+ 8.7	12.8	.68
		L	93.0	20.7	78.8	28.5	+14.2	10.6	1.34
	Supinat.	*R	99.4	11.0	69.4	37.0	+30.0	12.2	2.46
		*L	100.6	10.8	68.3	35.0	+32.3	11.5	2.80
Hand (at wrist)	Flex. (palm.)	R	95.0	10.6	93.0	17.2	+ 2.0	6.4	.31
		L	90.0	9.8	87.4	10.4	+ 2.6	6.6	.39
	Exten. (dors.)	R	54.1	15.2	58.3	8.3	- 4.2	5.4	.77
		L	65.7	12.6	58.1	13.0	+ 7.6	5.7	1.33
	Abduct. (rad.fl.)	R	27.1	7.1	25.7	8.6	+ 1.4	3.0	.46
		L	31.1	8.4	32.9	7.6	- 1.8	3.6	.50
	Adduct. (uln.fl.)	R	66.1	8.1	58.4	13.4	+ 7.7	4.9	1.57
		L	66.1	6.8	56.5	12.9	+ 9.6	4.7	2.04
Thigh (at hip)	Flex. (forw.)	R	97.8	17.0	94.5	17.3	+ 3.3	7.6	.43
		*L	105.6	8.3	91.4	13.8	+14.2	5.1	2.70
	Exten. (backw.)	R	48.4	12.9	36.6	16.6	+11.8	6.6	1.78
		L	42.4	9.9	40.0	14.2	+ 2.4	5.4	.44
	Abduct.	R	70.1	17.0	63.2	14.4	+ 6.9	7.0	.98
		L	71.7	14.1	60.5	14.3	+11.2	6.3	1.77
	Int.Rot.	*R	60.6	15.2	45.8	11.0	+14.8	3.9	2.60
		*L	66.3	13.5	44.9	9.3	+21.4	5.2	4.11
	Ext.Rot.	R	37.0	8.8	29.4	10.7	+ 7.6	4.0	1.90
		L	30.4	8.3	25.1	11.1	+ 5.3	4.4	1.18
Lower Leg (at knee)	Flex.	*R	126.6	8.7	95.1	12.2	+31.5	4.3	7.32
		*L	123.7	8.7	96.9	10.0	+26.8	3.8	7.05
Foot (at ankle)	Plant.Flex.	R	28.2	7.4	22.8	12.0	+ 5.4	4.7	1.14
		L	26.2	8.9	21.4	13.7	+ 4.8	5.1	.94
	Dors.Flex.	R	36.8	6.6	28.9	10.6	+ 7.9	3.9	2.01
		L	39.5	8.3	33.4	12.5	+ 6.1	4.7	1.29

TABLE 2

COMPARISON OF MENTALLY NORMAL AND MENTALLY DEFICIENT GROUPS IN MAXIMUM AMPLITUDE OF PASSIVE JOINT MOVEMENTS. (MEASUREMENTS IN ANGULAR DEGREES).

Part Moved	Mov't	Side	Mentally Normal (N) Mean	Mentally Normal (N) S.D. Mean	Mentally Deficient (MD) Mean	Mentally Deficient (MD) S.D. Mean	Diff. of Means (N-MD)	S.D. Diff	t=Diff./S.D. diff.
Head	Vent.Flex.		78.4	9.2	70.1	12.6	+ 8.3	4.9	1.20
	Dors.Flex.	*	77.2	25.1	55.7	18.5	+21.6	9.9	2.17
	Lat.Flex.	R	60.7	8.2	63.7	8.8	- 3.0	3.8	.79
		L	64.8	9.7	61.2	8.3	+ 3.6	4.0	.90
	Rotat.	R	96.6	14.1	90.0	11.2	+ 6.6	5.7	1.15
		L	95.4	11.1	89.8	12.4	+ 6.0	3.2	1.30
Upper Arm (at shoulder)	Flex.	R	104.6	6.4	170.3	8.5	+ 0.3	3.3	1.90
	(forw.)	L	105.4	6.2	170.4	8.9	+ 8.0	2.9	2.07
	Exten.	R	67.7	11.9	65.4	12.5	+ 2.3	5.5	.41
	(backw.)	L	70.3	10.2	61.3	15.0	+ 9.0	5.7	1.58
	Abduct.	R	136.7	12.4	135.2	8.1	+ 1.5	4.3	.35
		L	137.2	12.1	139.7	9.9	- 2.5	4.8	.52
	Int.Rot.	*R	101.1	22.6	81.2	12.7	+19.9	8.1	2.45
		*L	100.0	14.1	80.0	8.9	+22.0	5.4	4.07
	Ext.Rot.	*R	92.0	7.2	64.8	17.4	+27.2	5.9	4.61
		*L	92.2	13.9	66.0	13.0	+26.2	6.0	4.30
Forearm (at elbow)	Flex.	*R	143.2	7.6	133.1	9.6	+10.1	3.9	2.59
		*L	147.9	7.8	132.9	12.3	+15.0	4.6	3.28
	Pronat.	R	104.9	22.1	95.1	27.1	+ 9.8	11.0	.89
		L	111.2	15.1	97.7	20.6	+13.5	10.7	1.30
	Supinat.	*R	114.3	15.2	82.1	31.5	+32.2	11.0	2.91
		*L	116.0	13.0	84.0	30.0	+32.0	10.6	3.01
Hand (at wrist)	Flex.	R	105.6	13.0	101.0	13.2	+ 4.6	5.8	.79
	(palm.)	L	103.3	10.6	105.7	11.4	- 2.4	4.9	.49
	Exten.	*R	91.8	13.0	79.6	7.1	+12.2	4.7	2.59
	(dors.)	*L	104.2	19.0	79.8	8.9	+24.4	6.6	3.69
	Abduct.	R	39.7	6.1	34.4	9.5	+ 5.3	3.6	1.47
	(rad.fl.)	L	45.4	9.6	41.0	10.1	+ 4.4	4.4	1.00
	Adduct.	*R	74.1	7.4	63.3	12.3	+10.8	4.5	2.40
	(uln.fl.)	*L	74.5	6.7	63.6	10.4	+10.9	3.9	2.79
Thigh (at hip)	Flex.	R	111.5	9.2	103.4	18.5	+ 8.1	6.5	1.24
	(forw.)	L	112.9	9.6	100.7	17.2	+12.2	6.2	1.98
	Exten.	R	56.4	10.4	47.1	12.1	+ 9.3	5.0	1.86
	(backw.)	L	52.1	8.2	47.7	14.2	+ 4.4	5.2	.84
	Abduct.	R	79.3	10.4	74.7	14.0	+ 4.6	5.5	.83
		L	79.4	10.0	70.7	13.4	+ 8.7	5.3	1.64
	Int.Rot.	*R	73.0	16.6	54.3	10.8	+18.7	6.2	3.01
		*L	76.2	14.5	51.6	7.8	+24.6	4.6	5.34
	Ext.Rot.	R	45.8	6.7	36.3	12.1	+ 9.5	4.6	2.06
		L	39.2	8.4	34.0	10.0	+ 5.2	4.1	1.26
Lower Leg (at knee)	Flex.	*R	139.9	8.8	109.7	12.3	+30.2	4.4	6.86
		*L	136.3	7.6	107.8	11.0	+28.5	4.2	6.78
Foot (at ankle)	Plant.	R	36.1	9.9	29.7	12.7	+ 6.4	5.1	1.25
	Flex.	L	35.3	11.2	29.9	12.0	+ 5.4	5.2	1.03
	Dors.	R	43.9	4.7	39.2	11.1	+ 4.7	3.8	1.23
	Flex.	L	44.5	7.4	43.7	12.7	+ 1.0	4.6	.39

though not indicated in the tables, is that in certain movements (voluntary and passive flexion of the lower leg on both sides of the body) the distribution of measures of the two groups are completely exclusive. For these movements, all of the mentally deficient subjects show a smaller amplitude of movement than any of the mentally normal subjects. For all other movements examined, though there are differences in the arithmetic means of the two groups, the distributions overlap. The range of measures in the mentally normal and mentally deficient groups is shown for some illustrative movements in Figure 1. The movements represented are all those on the left side of the body for which the differences between the means for the two groups are statistically significant (in terms of a ratio t greater than or equal to 2.1).

IV. DISCUSSION

A. Reliability of results.

The results summarized above indicate that for the large majority of movements examined, the mentally deficient of the particular type and level examined show deficiencies in amplitude of joint movement compared with the mentally normal group. It is necessary to consider the extent to which this result may be regarded as reliable.

To determine the possible influence upon the means of so-called chance factors as represented by the dispersion of measures in the various distributions, the ratios t of the differences of the means to the standard errors of the differences have been determined. As already indicated, about one-third of the movements show statistically reliable differences in terms of a ratio t greater than or equal to 2.1. Even for the other movements, however, it must be regarded as significant that the differences between the mentally normal and mentally deficient groups are predominantly of the same sign, corresponding to a decreased amplitude of movement in the case of the mentally deficient. It is not unlikely that the use of larger groups of subjects would lead to statistically reliable differences in the case of many of the other movements. The effect of an increase in the number of cases in increasing the reliability of difference may rest on two factors: (1) the decrease in the value of the S.D. means and the derived $S.D._{diff.}$ as the number of cases increase, if the S.D. of the distributions remain about the same, and (2) the decrease in the critical ratio t that may be accepted as an index of statistical significance.

The adoption of a ratio for t equal to 2.1 as a criterion of statistical significance is based on Fisher's discussion of the statistics of small numbers (2). Fisher states that in a distribution containing a large number of cases, a critical ratio of 2 may be regarded as a satisfactory criterion of statistical significance (2, p. 113). If differences of means are being compared, a ratio of t equal to 2 corresponds to a probability of .975 that the "true" difference is greater than zero. (The corresponding value of the probability P, as defined by Fisher equals .05). If, however, a relatively small number of observations make up the distribution, then a somewhat greater ratio t is required to provide the same probability of a difference greater than zero. The tables of Student given in Fisher's book permits one to calculate how much greater this ratio must be. In the present study, 10 subjects were used in each experimental group. The corresponding number of degrees of freedom in the two groups is therefore 10, or two less than the number of subjects. Examination of Student's table of t values shows that for 18 degrees of freedom, a ratio t equal to 2.1 is necessary to provide a probability "P" equal to .05. A probability P equal to .05 corresponds to the probability of a difference greater than zero of .975. We have therefore adopted a ratio of t equal to 2.1 as a criterion of statistical significance in the present study. The value of the ratio of

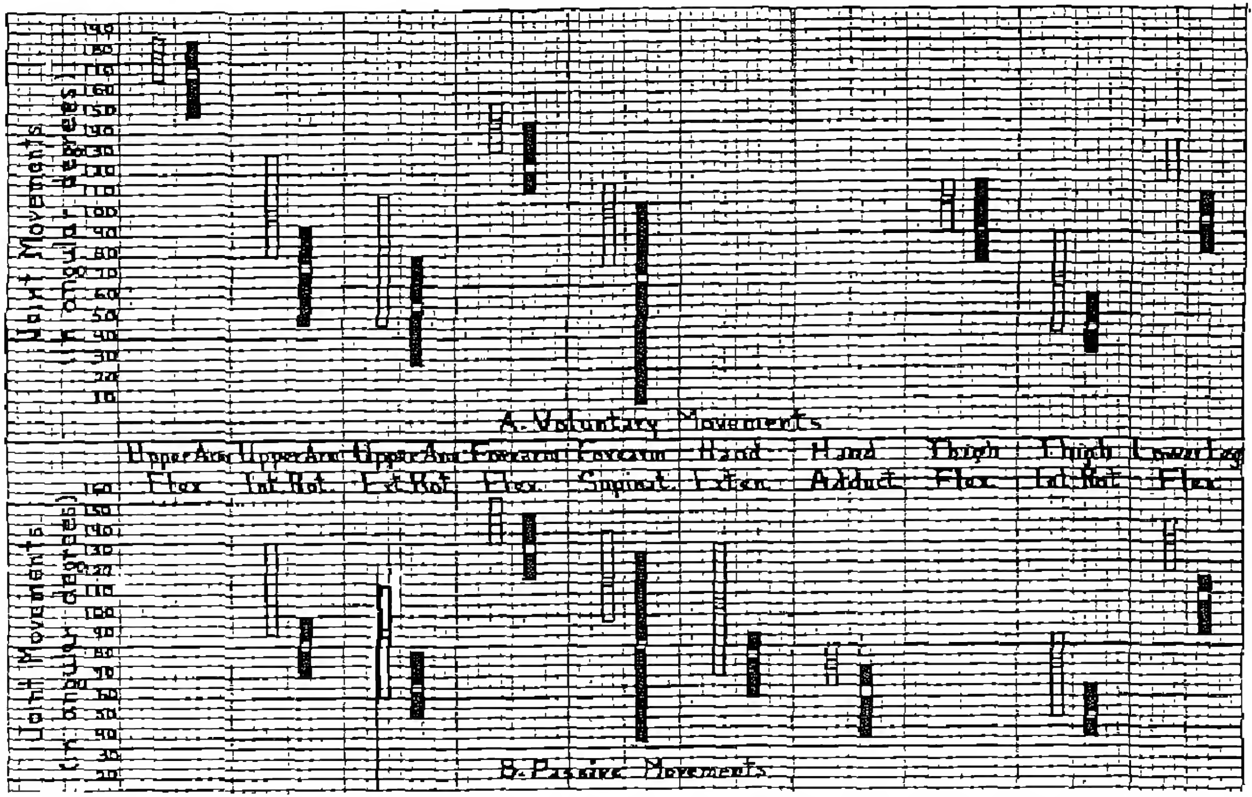

Figure 1. - Comparison of mentally normal and mentally deficient groups in range of variation of maximum amplitude of joint-movement for (A) voluntary movements, and (B) passive movements. The movements represented are all those on the left side of the body for which significant differences between the means of the two groups were found. Names of movements refer both to voluntary movements represented in upper part of chart and to passive movements in lower part of chart. Average values for various movements are indicated by small white squares drawn within the larger rectangles.

t used as a criterion of statistical significance is thus not appreciably altered by taking into account the limited number of cases. The advantage in the present instance of using the procedures outlined by Fisher lies, then, not so much in the quantitative effects upon t, but in the fact that we are provided with a theoretically sound basis for the determination of statistical significance, even when the number of cases is relatively small.

Sampling errors represent a second type of errors that may be involved in the results reported above. Tests for determination of statistical significance are not capable of exhibiting the extent to which sampling errors may be present. The results reported can therefore be regarded as but tentative and suggestive. To eliminate the possibility of such errors being present, similar investigations should be carried out with larger groups of subjects, selected under a variety of laboratory and institutional conditions. In such further investigations, time and labor might be saved by limiting the joints-movements examined to those in which the most marked and significant differences were found in the present study.

The possibility also exists that constant errors have influenced the results. Under this caption might be included any conditions that might have led the measurements of the mentally deficient subjects to deviate in a constant direction from the measurements of the normal group. We are not aware of the existence of such conditions in the present study, since care was taken to examine all subjects under precisely the same conditions. The carrying out of similar investigations by others in different laboratories is the best means for checking on the possible influence of errors of this type.

B. <u>Amplitude of joint-movement and type of mental deficiency</u>.

It should be borne in mind that the results reported above of limitations in amplitude of joint movement in the feeble-minded were obtained on a group of subjects selected on a particular basis. The results do not indicate, therefore, that similar limitations are to be expected in all types of mental deficiency. The existence of such associated defects of movements is likely to depend on the etiological type involved. It is commonly reported, for example, that individuals with mongolism are capable of an excessively wide range of movements at the joints. The tendency to deficiencies in amplitude of joint movement in the mentally deficient group of the present study suggests the desirability of a systematic and careful examination of the amplitude of joint movement among different etiological types and mental levels.

The mentally deficient group examined in the present study was itself not altogether homogeneous with respect to etiology. Half of the subjects was designated by the clinical division of the department as probably belonging to the hereditary type of mental deficiency. Etiology in the remaining subjects was specified as unknown. These subjects were like those in the hereditary group insofar as they were designated as belonging to "no special clinical type." It is quite likely that in the case of these subjects too, the mental deficiency is hereditary in origin. The data on family history, however, was not complete enough to permit this classification. It would be methodologically desirable in future studies of this sort if the various groups examined were made as homogeneous as possible with respect to probable etiology.

C. <u>Measurements of joint-movements as a possible aid to diagnosis.</u>

The results reported of differences in amplitude of joint movement in mentally deficient and mentally normal subjects raises the question of whether measurements of the type used might not be of help in the diagnosis of mental deficiency In the case of voluntary and passive movements at the knee joint, for example, the distribution of measures in the two groups of subjects did not even overlap. The confirmation of such results upon larger groups of subjects of various etiological types and mental levels would justify the use of such measurements as an additional diagnostic sign, assuming that factors other than mental deficiency that might be associated with deficiencies in joint amplitude were controlled.

D. Physiological factors underlying deficiencies in amplitude.

We may now inquire concerning the physiological factors which may have been responsible for the limitations in amplitude of joint movement found in the mentally deficient group. Factors of two kinds may be considered: (a) those which if increased in magnitude would lead to an increase in amplitude of joint movement; and (b) those which if increased in magnitude would lead to a decrease in amplitude of joint movement. We may refer to the former as facilitative factors and to the latter as restrictive factors. The facilitative factors, in the case of voluntary movement, consist of (1) degree of effort exerted by the subjects; and (2) the strength of the protagonist muscle groups, or more precisely, the torque which the protagonist muscle-groups provide for movement in a given direction when the subject makes his maximum effort. A decreased magnitude of these facilitative factors might help to account for a decrease in amplitude of voluntary movement in the mentally defective group. The assumption of such a decrease could not, however, explain the parallel decrease in amplitude of movement found in passive movements. In the case of passive movements, the strength and effort of the subject are not factors at all, inasmuch as the examiner supplies the force necessary to produce movement at any given joint. It seems more plausible, therefore, to attribute the deficiencies in amplitude of joint movement in the mentally deficient group to an increase in magnitude of the restrictive factors. These factors may be involved in both the case of voluntary and passive movements. The factors that may be included under this heading are: (1) the tonus or resistance to stretch of antagonistic muscle groups, as dependent, for example, on the elasticity and on the stretch reflex of the muscles, and (2) the tension of ligaments enclosing the joint, and which oppose excessive movement at a joint. It seems likely that one or both of these factors were responsible for the limitations of joint movement exhibited by the mentally deficient group in the present study. To determine which particular factors were responsible would require further investigation.

E. Developmental basis of decreased amplitude of joint-movement.

The deficiencies in amplitude of movement found for the mentally deficient group suggests the possibility that in individuals of the type considered, associated deficiencies in maximum amplitude of joint movement and in intelligence may be based on common developmental factors. In this connection it would be of interest to investigate the course of development of amplitude of joint-movement in the mentally normal, and in the mentally deficient of various etiological types. Similar developmental investigations of the various factors influencing joint

movement outlined above would also be of value. Investigations of this sort may provide an indirect method for determining the nature of the defective developmental agents responsible for the limitations of development found among the mentally deficient.

V. SUMMARY

The purpose of the present study was to compare the maximum amplitude of voluntary and passive joint-movement in sample groups of mentally normal and mentally deficient subjects. It represents part of a more general investigation being made of the motor properties associated with mental deficiency of various types. The subjects in both the mentally normal and mentally deficient groups examined were adults and comparable in chronological age, height, weight, and absence of signs of neuro-muscular disorder. The mentally deficient subjects were of no special clinical type, and ranged in mental age from 9 to 9.9 years. Measurements were made at practically all joints of the body by means of a plumb-line goniometer.

The mentally deficient group fell beneath the mentally normal group in maximum amplitude of movement in about 90% of the joint-movements examined. In about one-third of the movements, the differences found between mentally deficient and mentally normal groups were statistically significant. The possible causes of these differences were considered, and a number of different directions of further research suggested.

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THE MENTAL AND LINGUISTIC SUPERIORITY OF ONLY GIRLS

EDITH A. DAVIS[1]

While engaged in a major study[2] of linguistic ability in children at three discrete age levels, 5 1/2, 6 1/2, and 9 1/2 years, the writer compared 97 only children with 166 twins and 173 non-only singletons, selected on a percentage basis representative of the Minneapolis-St. Paul population, using the father's occupation as the criterion. The number of only children was made approximately equal to half the number of twins and non-only singletons, because the major objective of the study was a twin-singleton comparison rather than comparison of only and non-only children. About 57 per cent of all the subjects were at the 5 1/2 age level, because it was recognized that the kindergarten year is of crucial importance in the child's adjustment. Of the only children, 53 were 5 1/2 years old, 19 were 6 1/2, and 25 were 9 1/2, but the ratio of only to non-only children was kept nearly uniform at all ages, and the sexes were equally represented at all ages.

Early in the analysis of the data it was apparent that although only boys were superior to non-only boys in their use of language, only girls were superior to non-only girls in numerous phases of development. The findings are presented here in the belief that a real sex difference may exist in only children. Emphasis has been placed on the 5 1/2 year group because the large number of cases at this age makes the findings especially significant.

Intelligence of children in the 5 1/2 and 6 1/2 year groups are measured by the Pintner-Cunningham Primary Mental Test, and scores on the Pressey Intermediate Classification Test were secured for the 9 1/2 group. The mean I.Q. for only children at 5 1/2 and 6 1/2 years is slightly higher than that for children with siblings, although Table I indicates that this is not true for only boys from the lower occupational groupings.

Scores on the Pressey Test tended to be rather high, but there is no reason to question the value of the test as a means of determining relative standing. The findings at 9 1/2 years are based on incomplete returns taken from school records. More scores are missing for only children than for other children, and there are fewer cases, so that the apparent lack of superiority of only children at this age may be due to an error of sampling.

Table 2 suggests the probability of a real superiority of only girls over other groups in performance on the Pintner-Cunningham Test. Nearly all the critical ratios are so high as to indicate statistical reliability.

Both only boys and only girls use longer sentences than do children with siblings, although the difference is more consistent in girls than in boys. The

[1] From the Institute of Child Welfare, University of Minnesota.

[2] Davis, Edith A. The Development of Linguistic Skill in Twins, Singletons with Siblings, and Only Children. University of Minnesota, Institute of Child Welfare Monograph Series Number XIV. In Press.

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TABLE I

MEAN I.Q. OF ONLY AND NON-ONLY CHILDREN BY *AGE, SEX, AND OCCUPATIONAL GROUPING*

		Only children						Non-only children					
Age	Occup'l group	No.of boys	Mean I.Q	No.of girls	Mean I.Q.	No.of both sexes	Mean I.Q.	No.of boys	Mean I.Q.	No.of girls	Mean I.Q.	No.of both sexes	Mean I.Q.
*5½	Upper	13	108.1	13	114.2	26	111.1	45	106.2	46	104.5	91	105.3
	Lower	14	92.0	13	109.0	27	100.1	52	97.7	52	99.6	104	98.4
	All	27	99.7	26	111.6	53	105.5	97	101.6	98	101.9	195	101.7
*6½	Upper	4°	114.2	5	109.6	9	111.7	10	102.5	11	105.2	21	103.9
	Lower	5	100.6	4	114.0	9	106.3	12	98.7	11	102.9	23	100.8
	All	9	106.7	9	111.5	18	109.1	22	100.5	22	104.0	44	102.3
**9½	Upper	4	119.2	6	112.2	10	115.0	22	120.7	23	117.4	45	119.0
	Lower	5	114.2	6	116.3	11	115.4	22	107.4	24	116.8	46	112.3
	All	9	116.2	12	114.2	21°°	115.2	44	114.1	47	117.1	91	115.6

* Pintner-Cunningham Test Used. ° No Pintner-Cunningham score for one case.
** Pressey Test Used. °° No Pressey Score for four cases.

TABLE 2

COMPARISON OF THE MEAN SCORE OF 111.6 MADE BY 35 ONLY GIRLS ON THE PINTNER-CUNNINGHAM TEST WITH THE MEAN SCORE MADE BY OTHER GROUPS

Group	Number of Cases	Mean Score	S.D.	Mean S.D.	Critical Ratio
Twin boys	59	98.8	16.29	2.12	3.76
Twin girls	59	102.2	14.16	1.84	2.80
Singleton boys	60	103.6	16.05	2.07	2.02
Singleton girls	61	102.3	10.83	1.39	2.99
Only boys	36	101.4	18.72	3.12	2.49
All other girls	120	102.2	12.60	1.15	3.11
All other groups	275	101.8	15.12	0.91	3.50

findings of the major study indicate that mean length of sentence at the ages under consideration tends to increase at the rate of about half a word yearly. It is possible, therefore, to express this difference in terms of months of development as well as in number of words. Measured in this way, only children use a greater number of different words than do children with siblings. The mean annual increase in number of different words for all cases was 14.2 words, or 1.2 words per month. It is thus possible to obtain a quantitative expression of the advantage of only children at each age over comparable non-only children in the use of vocabulary. These findings are presented in Table 3.

"Onliness" apparently is as effective in inducing variety of word usage as ten

TABLE 3

ADVANTAGE OF ONLY CHILDREN OVER CHILDREN WITH SIBLINGS IN MEAN SENTENCE LENGTH AND IN MEAN NUMBER OF DIFFERENT WORDS USED, EXPRESSED IN NUMBER OF WORDS AND IN MONTHS OF DEVELOPMENT

Subjects		Superiority of Only Children in Mean Sentence Length		Superiority of Only Children in Mean Number of different Words	
Age in Years	Sex	Words	Months of Development	Words	Months of Development
5 1/2	Boys	.20	4	7.4	6
	Girls	1.16	28	18.2	15.2
	Both	.67	16	12.6	10.5
6 1/2	Boys	0	0	0	0
	Girls	.50	12	10.2	8.5
	Both	.25	6	2.3	1.9
9 1/2	Boys	1.20	29	22.4	18.7
	Girls	.71	17	14.8	12.3
	Both	.95	23	18.6	15.5
All	Boys	.31	7	8.5	7.1
	Girls	.94	22	15.7	13.1
	Both	.62	14	12.0	10.0

months of chronological age and increases the length of sentence as much as fourteen months of chronological age.

Since only children are more accustomed to the society of adults than are children with siblings, we should expect to find only children very much at ease in an experimental situation such as that set up for the collection of the remarks analyzed in this study. Only children did make a higher percentage of spontaneous remarks and asked rather more questions than non-only children. All the boys asked more questions than did the corresponding girls, but at 5 1/2 years the only girls asked more questions than the non-only boys. At 9 1/2 years the only children asked fewer questions than the non-only children, but this may be due to sampling, since few only children were studied at this age, and questions were rare in all 9 1/2 year old children. Although non-only boys made more spontaneous remarks than non-only girls, only girls at 5 1/2 and 6 1/2 years made the highest percentage of such remarks of any group. Tables 4 and 5 compare only and non-only children for spontaneity of response and number of questions.

At the close of the interview during which the child's remarks were recorded, the examiner rated all subjects for talkativeness and shyness. In these ratings and in length of time required to obtain 50 remarks only boys do not differ greatly from non-only boys, but only girls tend rather consistently toward less shyness and greater talkativeness than non-only girls. This is particularly true at 5 1/2 years. At this age 61 per cent of non-only boys and 74 per cent of only boys were not shy, as compared with 65 per cent of non-only girls and 81 per cent

TABLE 4

PERCENTAGES OF SPONTANEOUS REMARKS FOR ONLY AND NON-ONLY CHILDREN

Age in	Only Children			Non-only Children		
Years	Boys	Girls	Both Sexes	Boys	Girls	Both Sexes
5 1/2	83.2	88.0	85.6	79.8	72.4	75.2
6 1/2	82.0	88.6	85.2	80.6	77.8	79.2
9 1/2	82.2	60.4	70.8	70.8	61.6	65.4

TABLE 5

PERCENTAGE OF QUESTIONS FOR ONLY AND NON-ONLY CHILDREN

Age in	Only Children			Non-only Children		
Years	Boys	Girls	Both Sexes	Boys	Girls	Both Sexes
5 1/2	14.8	12.4	13.6	11.8	10.9	11.2
6 1/2	11.6	8.4	10.0	12.7	7.2	9.9
9 1/2	4.2	2.8	3.4	4.9	3.4	4.2

of only girls. The mean length of time required to secure 50 remarks is 13.5 minutes for both only and non-only boys, but the time for only girls is 13.1 minutes as compared with 14.5 minutes for non-only girls. At 5 1/2 years the difference is striking. The mean time for non-only boys is 12.9 minutes, for only boys 12.7 minutes; for non-only girls it is 13.3 minutes, but for only girls 10.1 minutes.

There may be a tendency for parents to send only girls to school as soon as permissible, but to keep only boys at home a little longer. The 48 twin girls in the 5 1/2 year group lacked 15 days of being exactly 5 1/2 years old, and their mean school experience was 13.5 weeks, while the 26 only girls lacked 10 days of being exactly 5 1/2 years old, but their mean school experience was 18 weeks. Only boys, on the other hand, were 8 days more than 5 1/2 years old, but had been in school only 15.6 weeks. Although this difference is probably due to sampling, it would be well to check the age at school entrance in future studies of only children.

At 5 1/2 years the articulation of only children was much better than that of twins, but not very much better than that of non-only singletons. The superiority of only girls over only boys in this regard was not so great as the superiority of non-only girls over non-only boys. Seventy-four per cent of only boys and 84.6 per cent of only g'rls had perfect articulation as measured by a rather lenient scale improvised for the purpose, but the corresponding percentages for non-only children were 51.3 and 70.1.

Table 6 summarizes the differences just discussed between only and non-only children at the 5 1/2 age level.

Although in most of the traits measured only boys are superior to non-only

TABLE 6

COMPARISON OF ONLY WITH NON-ONLY BOYS, AND ONLY WITH NON-ONLY GIRLS IN VARIOUS PHASES OF DEVELOPMENT AT 5 1/2 YEARS

Trait Measured	Boys: Only	Boys: Non-only	Difference in favor of only children	Girls: Only	Girls: Non-Only	Difference in favor of only children
I.Q.	99.7	101.6	-1.7	11.6	101.9	9.7
Mean length of sentence in words	4.65	4.46	.19	5.55	4.39	1.16
Mean number of different words	96.5	89.1	7.4	111.5	93.3	10.2
Number of spontaneous remarks	41.6	39.9	1.7	44.0	36.2	7.8
Number of questions	7.4	5.9	1.5	6.2	5.47	.73
Minutes required for interview	12.7	12.9	.2	10.1	13.3	3.2
Per cent rated very talkative	40.1	33.0	7.1	38.5	23.1	15.4
Weeks of school experience	15.6	15.9	-.3	18.0	15.2	2.8

boys, the difference is entirely consistent and much greater in the case of girls. The findings suggest that the only child situation may be extremely favorable to the intellectual and linguistic development of girls. Teachers in their discussions with the writer frequently referred to the only boys in their charge as "spoiled," "queer," or "nervous," but considered the girls well adjusted and normal. At all events, the possibility of a sex difference in only children should be considered in blocking out future studies. Such a difference may explain the conflicting results reported by students of only children.

A COMPARISON OF THE VIGOROUSNESS OF PLAY ACTIVITIES OF PRESCHOOL BOYS AND GIRLS [1]

EVALINE FALES

PROBLEM

One sex difference which has been little questioned is that of vigorousness of play activity. It has been taken for granted that boys take part in more vigorous activities than girls, and the few investigations which consider this problem seem to give supporting evidence.

Using the questionnaire method, Croswell (4) concluded that school-age boys are more interested in "amusements productive of motor development" than are girls. Lehman (7), using the checking method, states that boys participate more frequently in active plays and games, while girls tend to choose those of a sedentary type. This difference was reported even for his youngest subjects, who were five years old. McGhee (8), also using the checking method, had reported similar findings. Terman's (12) masculinity scale of play activities was constructed on the basis of the checking method and test questions. The more vigorous activities of the scale tend to be at the masculine end of the list and the less vigorous items at the other end.

It is doubtful whether either the simple questionnaire or the checking method has very much reliability when used with children. While the former may tend to cause recent activities to be overweighted, the latter is likely to suggest activities which might not otherwise be included. The observational method is a step towards more objective investigation of this problem.

On the basis of informal, uncontrolled observations of a group of kindergarten children in free play situations, Sisson (10) concludes that the older boys spent most of their time at active play; the older girls spent most of their time at dramatic play; and the younger children, both boys and girls, spent most of their time playing in the sand. A fourth group did little of anything.

The rest of the studies referred to are based upon controlled observation upon preschool children in free play situations.

Bridges (2), upon the basis of records of the per cent of time that each of ten three-year-olds spent at each play material, concludes that boys tend to choose equipment which promotes active play while girls choose materials which encourage quiet occupations. A later study made by the same investigator (3), using fourteen four-year-olds as subjects and using the number of choices of each material rather than the per cent of time, suggests that boys choose play equipment which encourages the use of large muscles while girls choose materials which promote finer co-ordination. Van Alstyne (13) in an elaborate study of play behavior concludes that boys choose materials which make for active play

[1] This study originated as a Master's Thesis at Mills College, under the direction of Dr. Harriet E. O'Shea. Subsequent work has been done at the Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

while girls tend to choose those which encourage more passive play.

Atkins (1), using the diary record method with five girls and five boys as subjects, states that sex has little influence upon type of play.

Although the above investigations indicate a difference in choice of play materials, conclusions regarding the total vigorousness of the children's activities do not seem justified. The judgment as to the vigorousness of an activity encouraged by the choice of a given play material is purely subjective. Moreover, the fact that one material can be used with varying degrees of vigorousness is entirely overlooked.

Although Sweeny, Hejinian, and Sholley (11) make no conclusions regarding sex differences, their study is of interest because of the method. This is the first attempt to differentiate between different degrees of vigorousness in a given activity. A five-point scale of vigorousness of eleven play categories was devised. Repeated short observations were made, recording the category of the play in which a child took part and the vigorousness of the participation as judged by the recorder at the time. Although this scheme permitted differences of vigorousness within each category, there was no way of judging differences from one category to the next.

Manwell and Mengert (9), using repeated short observations, checked a list of twenty-seven activities at one-minute intervals. One of the items on the list was physical activity. This was defined carefully and included play with mobile toys and large apparatus such as ladders, boxes, etc. The boys received a significantly higher score than the girls in this category. The score merely represents the number of times the item was checked and does not take into account degrees of vigorousness of physical activity.

Goodenough (6) used a similar but more refined technique. At the end of each fifteen-minute observation the child was rated with an appropriate number and letter according to the following categories:

0. No observable activity
1. Hand and arm movements only
   a. Active
   b. Strenuous
2. Hand, arm, trunk only
   a. Active
   b. Strenuous
3. Leg and trunk only
   a. Active
   b. Strenuous
4. Movements of whole body
   a. Active
   b. Strenuous

Even this method is subjective and lacks enough differentiation to give conclusive results.

PURPOSE

The purpose of this study was to investigate in a precise and objective manner sex differences in interest in vigorous activities and in quiet ones among preschool children as subjects.

METHOD

The method consisted of taking detailed diary records with the aid of a stop watch and classifying them according to A Rating Scale of the Vigorousness of Play Activities of Preschool Children (5) which was devised for the purpose of this study.

This scale consists of 651 items or activities in which preschool children engage. The items have been arranged into forty-eight levels of vigorousness by ten expert judges. This gives each item on the scale a vigorousness rating of from 1 to 48 depending upon which level of vigorousness it is in. Ratings of 1 represent the lowest degree and 48 the highest degree of vigorousness. The judges agreed highly in their classification of activities, the correlation of the ratings of half of the judges against those of the other half being .90.

SUBJECTS

The subjects were thirty-two preschool children, sixteen boys and sixteen girls, paired as nearly as possible according to chronological age. There were not enough children available to consider mental age and IQ in the pairings.

The children were selected from four different preschools in order that the group might be as unselected as possible. Seven pairs were taken from the Mills College preschool laboratory. The children were from American families above average in social status. Six pairs were taken from the Institute of Child Welfare at the University of California preschool. These children were mostly from professional families. Two pairs, Italians, and one pair of Russian twins were from philanthropic preschools of the Golden Gate Kindergarten Association in San Francisco. These children were from homes of low economic status. In spite of these three pairs, the group as a whole represents homes above the average. Table 1 gives more information about the subjects.

PROCEDURE

Recording the Data

The data consisted of detailed diary records including each activity in which the child engaged, together with the number of seconds spent at this activity. It was necessary for the recorder to be familiar with the items on the rating scale and to be experienced in recording with the aid of a stop watch.

In taking the data, time was equated carefully. Both children of a pair were observed upon the same day. Two observations were made upon each child, always upon consecutive days. The observations were arranged in such a way that if boy

TABLE 1

SEX, CHRONOLOGICAL AGE, MENTAL AGE, AND INTELLIGENCE QUOTIENT OF SIXTEEN BOYS AND SIXTEEN GIRLS

Boys*				Girls*			
Boy	Chronological Age	Mental Age	Intelligence Quotient	Girl	Chronological Age	Mental Age	Intelligence Quotient
1	25.5	30.6	120	1	24.0	22.3	93
2	29.0	30.2	104	2	26.5	27.5	104
3	34.0	46.6	140	3	34.0	38.4	113
4	35.0	42.2	120	4	35.5	43.0	121
5	34.0	55.4	163	5	36.0	41.8	116
6	36.0			6	36.0		
7	37.0	53.7	145	7	37.0	48.1	130
8	38.5	43.1	112	8	38.5	46.2	120
9	39.0			9	39.0		
10	42.0	53.8	125	10	42.5	56.5	133
11	42.5	48.5	114	11	43.5	58.3	135
12	47.0	58.8	125	12	44.0		
13	46.0	52.4	114	13	47.0	52.1	111
14	46.0	56.1	122	14	48.0	55.2	115
15	50.0			15	52.0		
16	53.0	61.5	116	16	54.0	56.1	103
Mean	39.9	48.5	126	Mean	39.9	45.3	117
S.D.	7.2	9.4	16.9	S.D.	7.9	11.1	13.0

*N=16

A were observed during the first part of the morning and girl A during the last part, on the following day girl A would be observed during the first part of the morning and boy A later.

Each of the two observations made upon a child was somewhat over forty minutes long. It was desired to retain two forty-minute records for each child after activities which had been influenced by adults and those few which could not be classified according to the scale had been eliminated. The final data consist of two forty-minute observations for each child except girl D, whose record is for thirty-four minutes and thirteen seconds.

The teachers in the group were aware of which child was being observed and tried to influence his activities as little as possible. The children were observed in a free play situation, almost always out of doors.

In each of the preschool situations there was approximately the same possibility for activity, the equipment being very similar.

Classification of Data

The diary records were classified according to the rating scale. For each item on the diary record the duplicate was found in the rating scale. Then the number of seconds spent at this activity as indicated by the diary record was multiplied by the vigorousness level as indicated by the rating scale. This product was called the multiplied score, and the total of the multiplied scores divided by the number of seconds represented in the record was the child's vigorousness score.[1]

[1] A few items, of the type which is self-limiting and therefore more vigorous the less time it takes to complete the activity, could not be treated in this manner, but corrected multipliers were used in place of the time (5).

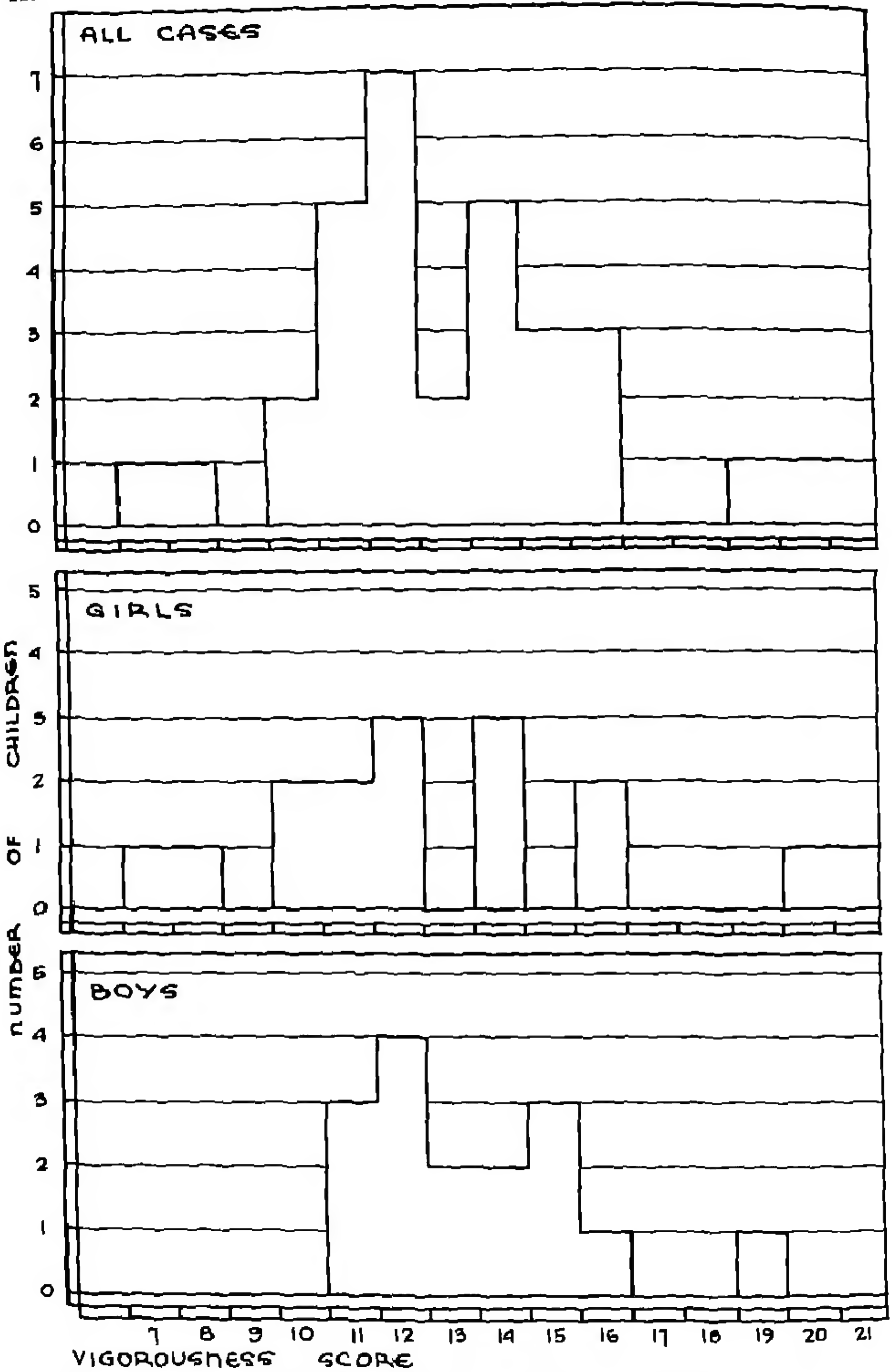

Figure 1. Distribution of the Children According to Vigorousness Score.

TABLE 2

MEAN VIGOROUSNESS SCORES FOR SIXTEEN BOYS AND SIXTEEN GIRLS

Boy	Boys* Observation First Hour	Boys* Observation Second Hour	Mean	Girl	Girls* Observation First Hour	Girls* Observation Second Hour	Mean
1	15.98	14.73	15.35	1	8.42	11.69	10.06
2	19.81	18.96	19.38	2	17.55	23.33	20.44
3	14.29	11.36	12.83	3	14.52	4.57	9.54
4	10.24	11.52	10.88	4	14.17	27.38	20.77
5	13.56	13.73	13.64	5	9.74	13.12	11.43
6	14.10	10.16	12.13	6	15.79	12.43	14.11
7	12.33	14.12	13.22	7	18.62	10.07	14.34
8	10.86	16.85	13.85	8	13.19	11.77	12.48
9	14.99	14.62	14.81	9	15.32	12.94	14.13
10	18.33	14.57	16.44	10	12.47	8.99	10.73
11	15.92	13.14	14.53	11	15.37	9.46	12.41
12	10.20	12.41	11.30	12	10.96	20.40	15.67
13	14.94	8.43	11.68	13	10.86	20.37	15.61
14	11.58	12.80	12.19	14	8.07	6.57	7.32
15	11.66	13.32	12.49	15	13.77	10.79	12.28
16	13.02	9.61	11.31	16	9.05	6.27	7.63
Mean	13.88	13.16	13.50	Mean	12.99	13.14	13.06
S.D.	2.69	2.56	2.14	S.D.	6.28	6.26	3.70

*N=16

Reliability of Taking the Data

In order to measure the reliability of taking data in this manner, two independent recorders took thirty-four five-minute records simultaneously. When each five-minute record was classified according to the rating scale, the correlation between the vigorousness scores representing the records of the two different recorders was .98 ± .01.

RESULTS

Central Tendencies

Table 2 shows the vigorousness scores for the children. The mean score for the boys is 13.50 and for the girls 13.06. These scores are very nearly alike and the difference is not statistically significant. When the difference between the means, .44, is divided by the standard error of the difference, the critical ratio is .41.

There is much variability within the group, and somewhat more among the girls than among the boys. The standard deviation of the girls' means is 3.70, while for the boys it is 2.14. The girls show a wider range in vigorousness scores; both the least vigorous child and the most vigorous child are girls.

The following tabulation shows the distribution of the children according to their vigorousness scores. Figure 1 shows the same thing graphically.

Vigorousness Score	Boys	Girls	All Cases
7	0	1	1
8	0	1	1
9	0	0	0
10	0	2	2
11	3	2	5
12	4	3	7
13	2	0	2
14	2	3	5
15	3	0	3
16	1	2	3
17	0	0	0
18	0	0	0
19	1	0	1
20	0	1	1
21	0	1	1
Total	16	16	32

Distribution of Time at Different Levels of Vigorousness

Although the mean scores show no sex differences in interest in vigorous activity, it seemed possible that further analysis of the data might reveal differences. It is possible that there was a difference between the sexes as to how their total time was distributed among the different levels of vigorousness. One child might take part in only very vigorous and very quiet activities and show the same total score as another child who spent all of his time at activities of about average vigorousness.

In order to investigate this time distribution, time was tabulated for each vigorousness level. Then, in order to have fewer levels of vigorousness for this study, the levels were grouped in fours, making twelve degrees of vigorousness rather than forty-eight.

The following tabulation* shows the per cent[2] of total time spent at each level of vigorousness for the boys, for the girls, and for all cases. Figure 2 shows histograms of these distributions. The extreme similarity between the distributions of the boys and the girls is very striking. None of the differences in these distributions is statistically significant. The largest difference between the per cent of time spent by the boys and by the girls is in vigorousness level 1 to 4. The difference is 5.16, but when this difference is divided by the standard error of the difference, the critical ratio is only 1.89. The critical ratios for all of the other differences are much less. This shows that there is not only no sex difference in vigorousness as shown by the means, but that there is also no difference as shown by the distribution of the time among the levels of vigorousness.

* See page 152.

[2] Because of the fact that in a few items a corrected multiplier was used instead of the time in obtaining the multiplied score (See footnote 1, p. 147), there would be a slight difference as to whether the per cent of total time (using time for all items in the records) or the per cent of total vigorousness (using the corrected multipliers where they occur in the data) were used in this analysis of the distribution. The tabulation was made in each way and the discrepancy proved to be so slight that it makes no difference in the final results which of the two methods is used.

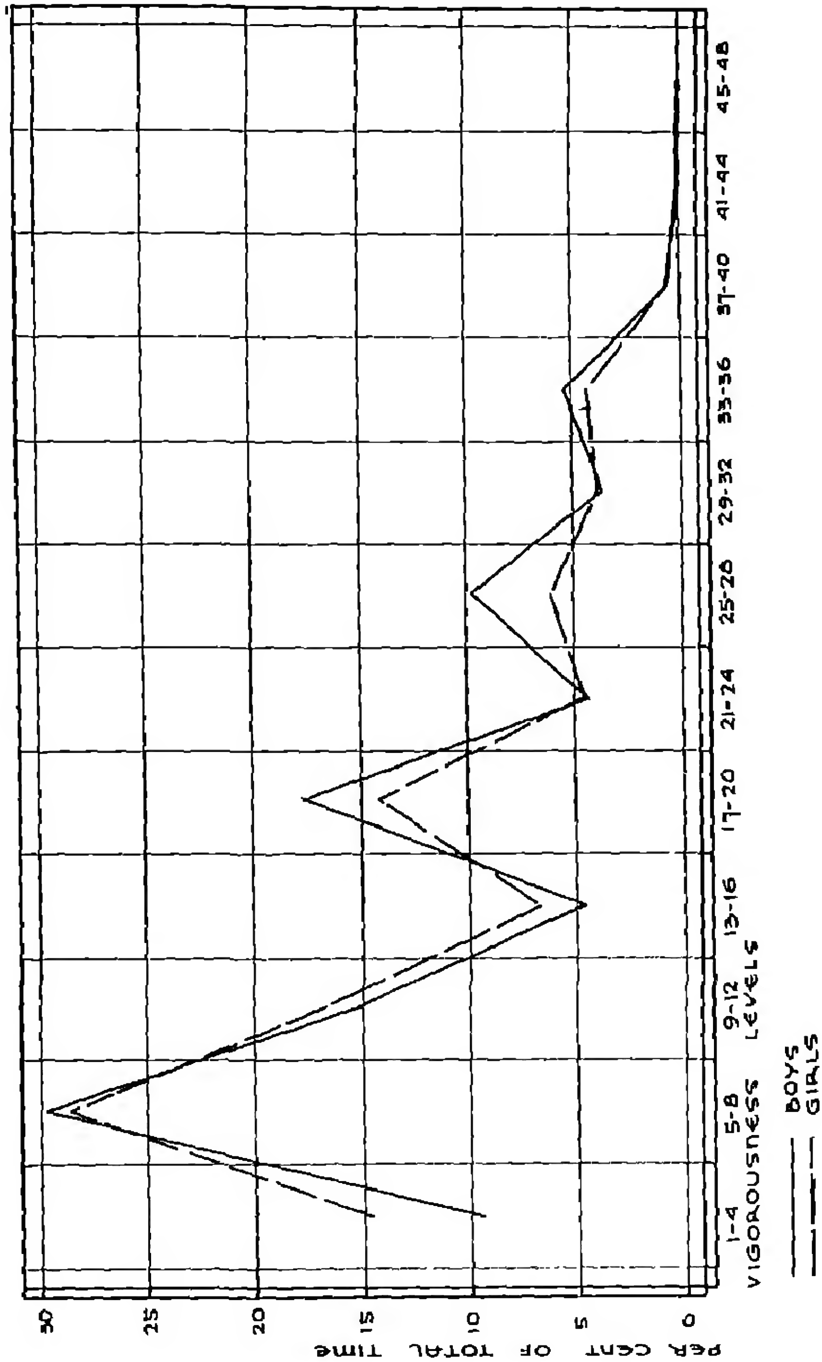

Figure 2. Distribution of Per Cent of Time Spent at Each Vigorousness Level for Boys and Girls.

Vigorousness Level	Boys	Girls	Differences	All Cases
1 to 4	9.51	14.67	5.16	12.09
5 to 8	29.77	28.45	1.32	29.11
9 to 12	15.00	16.77	1.77	15.89
13 to 16	4.66	6.68	2.02	5.69
17 to 20	17.45	14.23	3.22	15.84
21 to 24	4.29	4.61	.32	4.45
25 to 28	9.75	5.98	3.77	7.87
29 to 32	3.56	3.67	.11	3.62
33 to 36	5.31	4.32	.99	4.82
37 to 40	.64	.60	.04	.62
41 to 44	.01	.05	.04	.03
45 to 48	.05	.00	.05	.02

It is interesting to note that among both boys and girls a large per cent of the time is spent at the lower levels of the scale. Considering the boys and girls together, over 41 per cent of the total time observed is spent at vigorousness level 1 to 8. Over 57 per cent of the total time is spent in level 1 to 12.

Time of Day Differences

Another investigation which seemed of interest was to determine whether there were any differences in the vigorousness of the activities during the first part of the morning and during the latter part.

Two forty-minute records were obtained for each child, these records being on consecutive days but one always representing the first part of the morning and the other the latter part. The mean vigorousness score for all of the thirty-two children for the first hour was 13.42 and for the second hour 13.13. This is very nearly the same. When the difference of .29 is divided by the standard error of the difference, the critical ratio is .29, which indicates no significance.

Analyzing the data further, we find that there is also no significant difference between the vigorousness of the first and last hours if we consider the boys and girls separately. For the boys the mean score for the first hour is 13.86 and for the last hour 13.15. For the girls the mean for the first hour is 12.99 and for the second 13.14. This shows that the means reveal no significant time of day differences in vigorousness.

The data were further analyzed to determine whether there might be differences as to the per cent of time spent at each level of activity. Table 3 shows the per cent of time spent at each vigorousness level for each of the two-hour observations for the boys, the girls, and both together. Figure 3 shows histograms of these findings.

In only three of the vigorousness levels is the difference as much as 1 per cent. Both the boys and the girls spend more time taking part in activities of the lowest vigorousness level 1 to 4, during the last part of the morning. The reverse is true of the next two levels. Children spend more time at levels 5 to 8

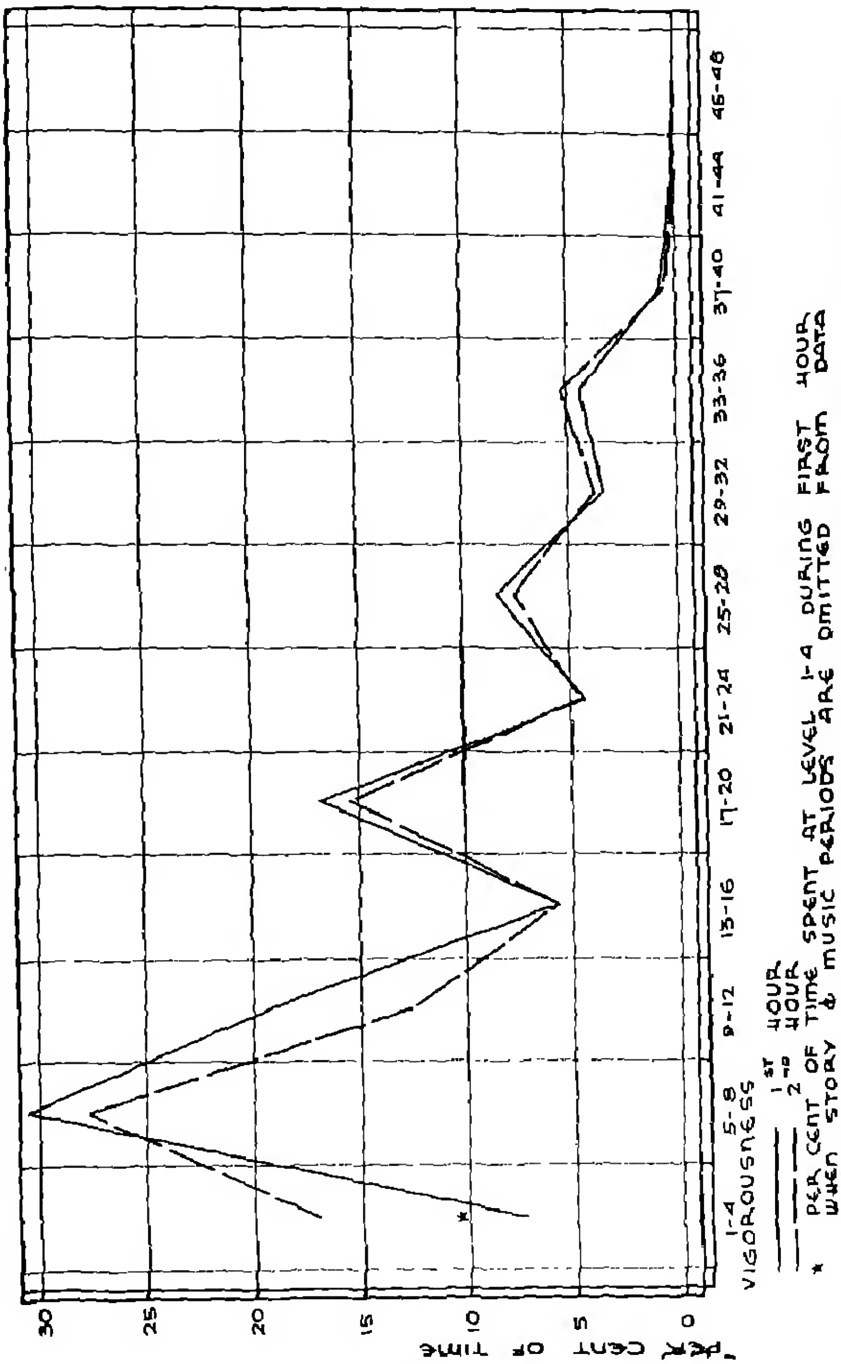

Figure 3. Distribution of Per Cent of Time Spent at Each Vigorousness Level During First and Second Hour.

TABLE 3

DISTRIBUTION OF PER CENT OF TIME SPENT AT EACH VIGOROUSNESS LEVEL DURING FIRST AND SECOND HOUR

Observation	Vigorousness Level											
	1 to 4	5 to 8	9 to 12	13 to 16	17 to 20	21 to 24	25 to 28	29 to 32	33 to 36	37 to 40	41 to 44	45 to 48
Boys												
First Hour	6.54	29.83	18.20	4.96	18.10	4.85	8.47	3.21	4.95	.84	.02	.10
Second Hour	12.57	29.72	11.81	4.37	16.80	3.73	11.01	3.92	5.66	.43	.00	.00
Difference	6.03	.11	6.38	.59	1.30	1.12	2.53	.71	.75	.41	.02	.10
Girls												
First Hour	7.91	31.45	20.01	6.29	14.45	3.66	8.15	3.51	3.88	.60	.11	.00
Second Hour	21.43	25.46	13.53	7.01	14.01	5.53	3.80	3.84	4.76	.61	.00	.00
Difference	13.52	5.99	6.48	.72	.44	1.87	4.35	.33	.88	.01	.11	.00
Both Sexes												
First Hour	7.23	30.64	19.11	5.63	18.28	4.26	8.31	3.36	4.42	.72	.07	.05
Second Hour	17.00	27.59	12.67	5.69	15.41	4.63	7.41	3.88	5.21	.53	.00	.00
Difference	9.77	3.05	6.44	.06	.87	.37	.90	.52	.79	.19	.07	.05

and 9 to 12 during the first part of the morning than during the latter part. In no case except in level 1 to 4 is the difference significant. This difference of 9.77, when divided by the standard error of the difference, gives a critical ratio of 3.53.

In one of the preschool situations in which the observations were made, a story period was sometimes held during the latter part of the morning. Although no verbal suggestion was made that the children join the group, this activity was made somewhat more available during the last period of the morning. Sitting listening to stories has a vigorousness of 2 and therefore would be within the 1 to 4 level.

In order to see how much effect the story period had, the time which any children spent sitting listening to stories was cut out of the data. Also two short periods of sitting listening to a music period were eliminated. This eliminated 4,128 seconds of data during the second hour of the girls' observations and 130 seconds of the first hour and 1,139 seconds of the second hour of the boys' observations. Records of six girls and four boys were involved.

When the per cent of total time spent in level 1 to 4 was worked after the story and music periods had been eliminated from the data, quite different results were obtained. The results follow:

Hour	Boys	Girls	All Cases
1	6.20	7.91	7.05
2	9.61	10.67	10.14

The per cent of time is still slightly greater for the second hour, but the difference is no longer statistically significant. Thus we find that the only difference due to time of day was the result of more quiet activity being made

available at one time than at another.

In the analysis of the difference due to time of day we again find a striking similarity between the distributions of the boys and the girls.

Day-to-Day Differences

There was much variability from one day to the next. The correlations between Observation 1 and Observation 2 (this is not the same as first hour and second hour) were .38 for the boys and .15 for the girls.

Relation Between Vigorousness and Other Factors

In order to ascertain whether vigorousness has any relation to chronological age, mental age, or IQ, correlations were calculated. They will be found in Table 4.

TABLE 4

RELATIONSHIP BETWEEN VIGOROUSNESS AND OTHER FACTORS

Variants	Girls		Boys		Both Sexes	
	r	P.E.	r	P.E.	r	P.E.
Corrections of Zero Order						
Chronological Age and Vigorousness	-.34	.16	-.47	.13	-.44	.10
Mental Age and Vigorousness	-.33	.17	-.68	.13	-.30	.12
IQ and Vigorousness	.06	.18	-.19	.18	.00	.14
Chronological Age and Mental Age	.08	.05	.84	.05	.85	.04
Chronological Age and IQ	.65	.14	-.16	.18	.00	.14
Mental Age and IQ	.66	.11	.38	.14	.20	.13
Correlations of First Order						
Chronological Age and Vigorousness (Mental Age Constant)	-.11		-.05		-.22	
Mental Age and Vigorousness (Chronological Age Constant)	-.08		-.38		-.03	
IQ and Vigorousness (Mental Age Constant)	.40		.04		.12	
IQ and Vigorousness (Chronological Age Constant)	.32		-.30		.00	
Chronological Age and IQ (Mental Age Constant)	-.07		-.97		-.46	
Mental Age and IQ (Chronological Age Constant)	.44		.98		.63	
Correlations of Second Order						
Chronological Age and Vigorousness (Mental Age and IQ Constant)	-.09		.33		-.19	
Mental Age and Vigorousness (Chronological Age and IQ Constant)	-.25		-.43		-.04	
IQ and Vigorousness (Chronological Age and Mental Age Constant)	.39		.04		.02	

In the correlations of zero order we find a significant negative correlation between chronological age and vigorousness and between mental age and vigorousness - the former -.44 ± .10 and the latter -.30 ± .12. It seems that in a nursery school situation children with low chronological and mental ages tend to take part in more vigorous activities than the children chronologically and mentally older. There is no significant relation between IQ and vigorousness.

In order to find which factor is the most closely associated with vigorousness, partial correlations were found. From these correlations it seems that vigorousness is more dependent upon chronological age than upon mental age. The partial correlation between chronological age and vigorousness, holding mental age constant, is -.22. The partial correlation between mental age and vigorousness, with chronological age constant, is -.03.

This tendency of the younger children to take part in more vigorous activities than the older children might be due to their habit of running about from one thing to another, while the older children frequently settle down to one activity for some time. Further analysis of the data would indicate whether this supposition is correct.

Reliability of Data

The reliability of the data as measured by a rank correlation of the vigorousness scores between the odd and even five-minute periods of the observations is high. After being corrected by the Spearman-Brown formula, the correlation for the boys is .88 ± .09, for the girls .93 ± .06, and for both together .92 ± .03.

SUMMARY

1. The purpose of this study was to study sex differences in vigorousness activities.

2. The subjects were thirty-two preschool children, sixteen boys and sixteen girls, paired according to chronological age.

3. The procedure was to take detailed diary records, two forty-minute records for each child, and classify them according to the Scale of the Vigorousness of Activities of Preschool Children. In this way a vigorousness score was obtained for each child.

4. The mean vigorousness score for the boys was 13.50 and for the girls 13.06. This difference is not statistically significant.

5. Much variability is shown within the groups, the girls showing more variability than the boys.

6. The per cent of total time was found in each of twelve large levels of vigorousness (the forty-eight levels being grouped into fours). The boys and girls showed similar distributions, no significant difference being found in any level.

7. Both the boys and the girls spent a large per cent of time in the lower levels of vigorousness, over 57 per cent of their total time being spent at level 1 to 12.

8. When the effects of a few instances in which more quiet activities were available during one part of the morning than at other times were eliminated, there

were no significant differences due to time of day in the vigorousness of the activity. In this analysis also the girls and the boys showed striking similarity.

9. There was great variability of vigorousness of activity from one day to the next.

10. There is a slight tendency for the younger children to have higher vigorousness scores than the older children.

11. The data are reliable as shown by correlations between the odd and the even five-minute periods. The correlation is .92 when corrected by the Spearman-Brown formula.

CONCLUSIONS

This study shows striking similarity between the vigorousness of the activities of preschool boys and girls. Not only are the mean vigorousness scores almost identical, but the per cent of total time they spend at each vigorousness level is almost the same. This is true for both the first hour and the last hour of the morning. Moreover, the mean scores of the boys and the girls for the first and the last hours are very much alike.

These striking similarities in every comparison which was made seem to eliminate the possibility that the likeness is due to chance and would disappear if more cases were used.

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THE EFFECT OF TRAINING ON RHYTHMIC ABILITY AND OTHER PROBLEMS RELATED TO RHYTHM

MINNIE GIESECKE WIGHT

In an effort to make some useful contribution to the motor phase of the educational program at the Country Home for Convalescent Crippled Children, in Chicago, a general study of rhythm was undertaken at that institution during the winter and spring of 1936 by the writer, under the direction of Professor Frank N. Freeman, of the University of Chicago.

For a description of the Country Home and its educational activities, the reader is referred to an article[1] by Loretta Maud Miller in Occupational therapy and rehabilitation of August, 1934. By way of brief explanation, however, the Country Home for Convalescent Crippled Children is an institution affiliated with the University of Chicago and located in the country some forty miles west of the city of Chicago. Its purpose is the provision of convalescent care for children referred from various hospitals in Chicago, but particularly from the orthopedic hospital in the University Clinics. Almost all cases admitted to the Home involve some form of disturbance of the skeletal structure of the body, and facilities for as many as one hundred children, including bed, semi-ambulatory, and ambulatory patients, are found in the Home.

Since convalescence in orthopedic cases frequently covers an extended period of time, and since the typical age range included in the group of patients is from four to fourteen years, educational as well as medical care is provided. As part of a research program in connection with the educational department of the Country Home, this investigation of some of the problems of rhythm was instituted.

DESCRIPTION OF THE TESTS

The two chief questions for which answers were sought in this study were: first, is rhythmization an ability which can be increased by training; and, second, is there a relationship between rhythmic ability and general motor ability.

In order to attack either of these problems, it became necessary to develop a rhythm test or tests which would be suitable for use in the Country Home situation and which would meet the demands of scientific standards as to reliability. Similarly, in order to attempt to find an answer to the second question, a suitable motor coordination test needed to be determined upon.

On the assumption that a test of ability to reproduce rhythm patterns would be a test of ability to rhythmize, considerable preliminary work was devoted to the construction of such a test. First efforts made use of a revolving disc operated by a phonograph motor. On the disc were placed contacts so arranged that the following rhythm pattern was produced by strokes of a magnetic hammer, to which the disc was wired:

[1] Loretta Maud Miller, "Educational work for orthopedic children," Occupational therapy and rehabilitation, vol. 13, No. 4, August, 1934, pp. 223-232.

Tap, tap, tap, pause, tap, pause,
Tap, tap, tap, pause, tap, pause, etc.

Included in the circuit was an especially devised tapping board and a kymograph on which could be automatically recorded, in ink, both the rhythm pattern set by the hammer and the response tapped on the keys of the tapping board. The kymograph was equipped with a time-line pen.

The tapping board devised for this preliminary study was made up of a set of six keys arranged in a circle having a diameter of eight inches. The keys were placed equidistant from one another and their positions were fixed. Slight pressure on any one of the keys depressed it sufficiently to make contact with a brass plate, closing an electric circuit. This closure operated an electric marker, and this, in turn, produced sideward movement of the kymograph pen. Paper passing under the kymograph pens received this automatic record of performance on the tapping test. This tapping mechanism was utilized both for a response key in the rhythm test and as a special motor coordination test.

Using a group of 28 of the older children available at the time, a preliminary study was made through which techniques were determined upon for both the rhythm and the motor coordination tests to be used in the main study. Following this preliminary study, improved equipment was secured.

A new disc was constructed, on which were set contacts so arranged that the following four different rhythm patterns, of graduated difficulty, could be sounded by the magnetic hammer:

Pattern I	Tap, pause, tap, pause, tap, pause, etc.
Pattern II	Tap, tap, tap, pause, tap, tap, tap, pause, etc.
Pattern III	Tap, tap, tap, pause, tap, pause, Tap, tap, tap, pause, tap, pause, etc.
Pattern IV	Tap, tap, pause, tap, tap, tap, pause, pause, Tap, tap, pause, tap, tap, tap, pause, pause, etc.

In place of the phonograph motor, an electric motor with a rheostat was attached to the disc, insuring constant speed in the rhythm pattern. A switch was attached so that the hammer could be turned on and off at will.

A new tapping mechanism also was constructed, similar to the original one but larger in diameter (11" in place of 8"), in order to utilize larger arm movement for the motor coordination test.

Rhythm tests.--The following technique was adopted for the rhythm tests. An explanation was given of the object of the test; the hammer was sounded and the key most convenient to the child (depending upon hand-preference and upon type of physical handicap) was tapped by way of demonstration; finally, the child was asked to tap on the key in unison with the sound. Two successive trials (made up of a series of repetitions of the pattern specific in number for each of the four rhythm patterns) were given, followed by an explanation that in the next trial the child should again "do his best to tap right with the sound," but that "after a

while" (actually at the end of a series of equal length with each of the first two trials) the sound would be turned off and he should "keep right on tapping in the same way" until told to stop. This last series was equal in length to each of the first three. Thus, four trials of equal length were given, the first three requiring performance in unison with the sound of the hammer, and the last requiring reproduction of the rhythm pattern without the sound stimulus.

Each of the four patterns was presented in this way, and trials were taken on all, unless it was found that a child was unable to follow the pattern during the entire first trial. In that case no further trials were undertaken.

Pattern IV was found to be too difficult to be useful with so young a group of children. Pattern III was also too difficult for most of the younger children, although satisfactory for the older ones. Pattern II, however, was suitable throughout the entire age scale, although perhaps a little too easy at the upper age levels. Unless otherwise indicated, therefore, reference hereafter to the rhythm test is reference to performance on Pattern II of the rhythm tests.

In scoring the rhythm tests, the first two performances of the pattern were considered to be preliminary and were not scored. In the case of Pattern II, the score was then based upon twelve repetitions of the pattern, which produced 36 intervals between taps. Each interval was measured and counted correct if within a tolerance of 10% plus or minus; otherwise, incorrect. A possible score of 30 could thus be achieved on Pattern II.

The score for each trial was translated into terms of percentage accuracy. It was found, upon retesting, that the highest reliability was secured by using as the final score an average of the scores on the four trials. The test was therefore so scored.

Motor coordination tests.--Two types of performance were secured with the use of the tapping mechanism as a motor coordination test. The first involved speed of tapping back and forth on two adjacent keys. Explanation and demonstration indicated the object of the test, which was to tap back and forth on the two keys as rapidly as possible during a period of eleven seconds. Two successive trials were given, and each was scored in terms of total number of taps recorded on the kymograph paper during the eleven-second interval. The exact time-interval was indicated on the kymograph paper by the time-line pen. For the final score on this two-key tapping test, the scores on the two trials were averaged.

The second tapping test required tapping for speed on all six keys in consecutive order, and again two trials were given. This test involved full arm movement, while the two-key test required movement only of the hand and forearm. The same time-interval and the same scoring method were used for this six-key as for the two-key tapping test just described.

Since these two tests showed almost equal reliability, and because the six-key test was thought to involve more complex motor coordination than the two-key test, the former was used for all comparative purposes. Hereafter, therefore, the six-key tapping test is referred to whenever reference is made to the motor

coordination test.

Other records secured.--With the use of a hand-dynamometer, records of strength of grip were taken. In addition, chronological age, at the time of first testing, and intelligence quotients were determined.

RELIABILITY OF THE TESTS AND THEIR INTERRELATIONSHIP

Tests were administered, according to the techniques described, to a group of 47 children, all ambulatory cases, ranging in age from 57 to 187 months. This age range makes an unsatisfactory setting for this type of experimental study, but the investigation necessarily had to be carried on in the situation which prevails at the Country Home

Figures 1, 2, and 3 are distribution curves of the scores on the initial tests of rhythm, motor coordination, and strength, respectively, and indicate that all three tests do differentiate between individuals.

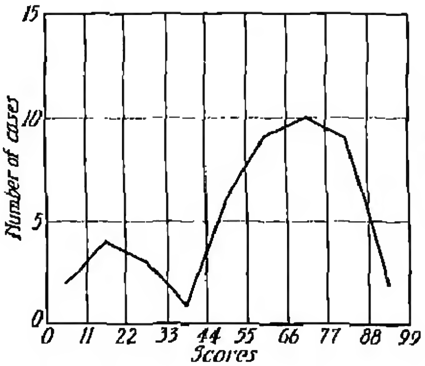

Figure 1. Distribution of scores on rhythm test.

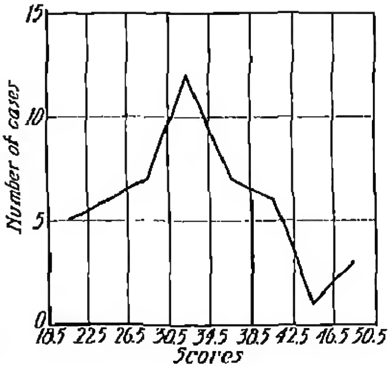

Figure 2. Distribution of scores on motor coordination test.

In order to establish the reliability of the tests, retests were administered within two weeks time. Table I gives the reliability coefficients, with their probable error values, showing high reliability in all cases.

In order to determine the relationship between these several tests and also their respective relationships with chronological age and intelligence quotient, intercorrelations were calculated and are shown in Table II.

As was to be expected, a high positive

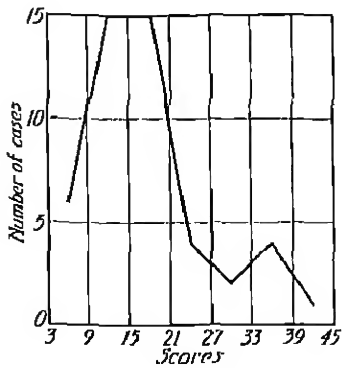

Figure 3. Distribution of scores on strength test.

TABLE I

RELIABILITY COEFFICIENTS

Test	r
Rhythm	.91±.02
Motor coordination	.91±.02
Strength of grip	.96±.008

correlation, many times larger than its probable error, is found between strength and chronological age (.83±.03); an equally high positive correlation between motor coordination and chronological age (.82±.03); and although not quite so high, also a significant positive correlation between rhythm and chronological age (.61 ±.06).

TABLE II

INTERCORRELATIONS OF TESTS

	Rhythm	Motor Coordination	Strength	Chronological Age	IQ
Rhythm	-	.70±.05	.62±.06	.61±.06	.02±.10
Motor Coordination	.70±.05	-	.75±.04	.82±.03	.19±.09
Strength	.62±.06	.75±.04	-	.83±.03	-
Chronological Age	.61±.06	.82±.03	.83±.03	-	-.06±.10
IQ	.02±.10	.19±.09	-	-.06±.10	-

Since there was evidence to indicate some decrease in IQ with increase in age in the group used as subjects for this study, the correlation between chronological age and IQ was calculated and proved to be a small negative quantity (-.06 ±.10), not significant when compared with its probable error.

In order to eliminate this influence of age and determine the true relationship between the several factors under consideration in this study, partial correlations were calculated, holding age constant, with results as shown in Table III.

TABLE III

INTERCORRELATIONS HOLDING AGE CONSTANT

	Rhythm	Motor Coordination	Strength	IQ
Rhythm	-	.44±.08	.26±.09	.07±.09
Motor Coordination	.44±.08	-	.22±.09	.42±.08
Strength	.26±.09	.22±.09	-	-
IQ	.07±.09	.42±.08	-	-

With the age factor eliminated, it will be seen that the correlation between strength and rhythm and between strength and motor coordination drop to figures

that are not significant when compared with their probable errors. The relationship between motor coordination and rhythm, however, remains sufficiently high to be significant (.44±.08), while that between motor coordination and intelligence increases sufficiently to become significant (.42±.08).

It would seem from these figures, therefore, that rhythm (as here tested) and intelligence (as reflected in the intelligence quotient scores) are two components in motor coordination (as tested by the six-key tapping test).

EFFECT OF TRAINING ON RHYTHMIZATION

Comparison of the results of the initial test of rhythm with those of the retest indicates the presence of a large learning element due to the practice effect of the test, itself. (See Figs. 4 and 5 and Table V.)

In order to study the effect of general rhythmic training on rhythmization as tested, two groups of thirteen subjects each, matched as nearly as possible for chronological age, IQ, and rhythmization as indicated on the initial rhythm test, were selected for experimental purposes. One of each matched pair was placed in an experimental group and the other of each matched pair in a control group. These two groups will hereafter be referred to as Experimental Group A and Control Group A'.

Both the experimental and the control groups were then enlarged by adding a few unmatched subjects to each group. The enlarged experimental group, hereafter referred to as Experimental Group B, thus includes the thirteen matched individuals plus five unmatched subjects (total of eighteen subjects), while the enlarged control group, hereafter referred to as Control Group B', includes the thirteen matched individuals plus four unmatched subjects (total of seventeen subjects).

During a period of approximately two months following the retesting, no use, whatever, was made of the tapping mechanism. Throughout this period, the experimental subjects (total group of eighteen children) were given a regular program of rhythmic activities, classes meeting two or three times each week until a total of eighteen class periods had been completed. During this time, the control subjects were left to the usual routine of the Home, taking no part in the rhythm-activities program.

The writer, who has had physical education teaching experience, conducted the rhythm classes, with the assistance of a pianist. Phonograph music supplemented that of the piano on some occasions.

The following activities were included in the rhythm program: tapping, with sticks, rhythm patterns in time with music of both 2/4 and 3/4 time; tapping sticks in unison with rhythm patterns set by the instructor on a tom-tom, the patterning in this situation produced by differences in accent rather than differences in timing; the same types of tapping of rhythm patterns using the foot, in place of sticks held in the hands; beating time with various types of music, using a stick as a baton; a complete rhythm band; marching with and without music; folk dancing; and tap dancing.

Large body activities were impossible for four of the children in the experimental groups, because of their physical disabilities. These individuals used rhythm band instruments (sticks, drums, and bells) to keep time with whatever music was used, throughout the practice periods. Their training was thus of a more specific nature than was that of the remainder of the group.

The order of progression in the rhythmic activities was from small to large muscle-groups, with emphasis on large body activities toward the end of the training period, although the rhythm band was kept in use throughout, as it met with such enthusiasm on the part of the children. The dancing was necessarily limited in scope, since in many cases the physical disability affects the lower extremities. With the exception of the children already mentioned, however, who were unable to take part at all, most of the youngsters made a genuine effort to keep up with the steps of the dance or march even though it was necessary to use some ingenuity where a knee, for example, was restricted by a cast.

At the completion of the training program, a final test of rhythm was administered, according to the described technique, and comparisons made between the experimental and control groups.

TABLE IV

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS IN SIZE, INTELLIGENCE, AGE, AND STRENGTH

Subjects	Number	IQ		Age in Months		Strength (Grip)	
		Ave.	Range	Ave.	Range	Ave.	Range
Experimental Group A (Matched)	13	88	64-111	108	72-143	14.4	7.0-22.0
Control Group A' (Matched)	13	88	75-104	111	68-136	15.8	11.0-20.5
Experimental Group B (Matched plus unmatched)	18	89	64-111	103	57-143	12.7	4.0-22.0
Control Group B' (Matched plus unmatched)	17	88	66-104	110	68-136	15.6	11.0-20.5

Table IV gives comparisons of the experimental and control groups as to size, intelligence quotient, age, and strength. It will be noted that the control groups show slightly higher average age and average strength scores than do the experimental groups. The difference between Experimental Group B and Control Group B' is greater than that between Experimental Group A and Control Group A', due, no doubt, to the fact that several of the unmatched experimental subjects were in the youngest age classification.

Figures 4 and 5 show graphically the mean rhythm scores of the four groups on the initial test, the retest, and the final test. Several important tendencies are evident from observation of these figures.

In both cases, the control group shows a higher score on the initial test than does the experimental group. This is to be expected, since the average age of the control groups is higher than that of the comparable experimental groups, and a

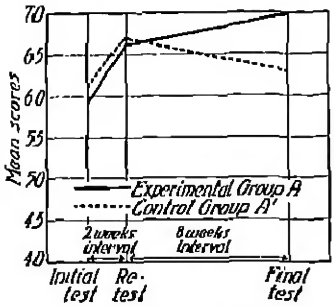

Figure 4. Mean scores on rhythm test for Experimental Group A and Control Group A

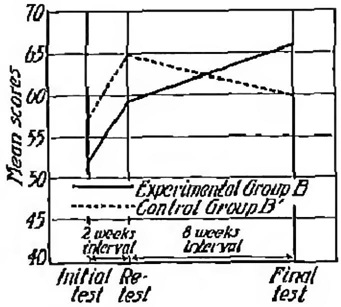

Figure 5. Mean scores on rhythm test for Experimental Group B and Control Group B'

high relationship between rhythm and age has been shown to obtain.

Again, it will be noted that for all groups improvement is shown on the retest, indicating the presence of practice effects in the performance of the tests.

Finally, the control groups are shown to have dropped back on the final test to approximately the level of their initial performance, whereas the experimental groups show improvement on the final test above that indicated on the retest.

TABLE V

MEAN RHYTHM SCORES ON SUCCESSIVE TESTS

Subject Groups	Initial Test	Retest (After 2 weeks)	Final Test (After 2½ months)
Experimental Group A (Matched)	58.7	66.1	69.5
Control Group A' (Matched)	61.5	67.1	62.9
Experimental Group B (Matched plus unmatched)	52.0	59.1	65.8
Experimental Group B' (Matched plus unmatched)	57.4	64.6	59.8

Analysis of Rhythm test scores.--Table V gives the successive means upon which the curves of Figures 4 and 5 are based. Table VI shows comparisons of these means in terms of percentage change. Table VII gives the differences between the means of the initial and the final tests, with their probable error values.

Since the groups are so small, the probable errors of the differences of the means are very large so that these differences do not satisfy the requirements for statistical significance. It is noteworthy, however, (see Table VII) that for Experimental Group A the difference of the means is more than twice as large as its probable error, and for Experimental Group B the difference of the means is

TABLE VI

COMPARISON OF MEAN RHYTHM SCORES ON SUCCESSIVE TESTS IN TERMS OF PERCENTAGE CHANGE

Subjects	Retest Compared With First Test (14-day interval)	Final Test Compared with Retest (60-day interval)	Final Test Compared with First Test (75-day interval)
Experimental Group A (Matched)	12.6% gain	5.1% gain	18.4% gain
Control Group A' (Matched)	9.1% gain	6.2% loss	2.3% gain
Experimental Group B (Matched plus unmatched)	13.6% gain	11.3% gain	26.5% gain
Control Group B' (Matched plus unmatched)	12.5% gain	7.4% loss	4.2% gain

slightly more than three times its probable error, while for both control groups the probable error of the difference of the means is larger than the difference, itself.

TABLE VII

DIFFERENCES OF THE MEANS OF INITIAL AND FINAL RHYTHM TESTS, EXPERIMENTAL AND CONTROL GROUPS

Subject Group	M - M'
Experimental Group A (Matched)......................	10.8 ± 4.54
Control Group A' (Matched).........................	1.4 ± 4.01
Experimental Group B (Matched plus unmatched).......	13.0 ± 4.36
Control Group B' (Matched plus unmatched)..........	2.4 ± 4.20

The difference in performance of the experimental and the control groups on the rhythm test is also noteworthy when shown, as in Table VI, in terms of percentage change from test to test. All four groups improved their mean scores on the retest, above those made on the initial test. However, due to the fact that the experimental groups continued their improvement on the final test while the control groups lost on the final test a good deal of the gain they had made on the retest, the percentage differences between the initial test and the final test are the following: 18.4 per cent gain for Experimental Group A as compared with 2.3 per cent gain for Control Group A'; 26.5 per cent gain for Experimental Group B as compared with 4.2 per cent gain for Control Group B'.

Finally, it seems well to show comparisons of individual records of the subjects making up the several groups. Figures 6 and 7 show the scores made on successive tests by the matched pairs, while Figures 8 and 9 give the individual

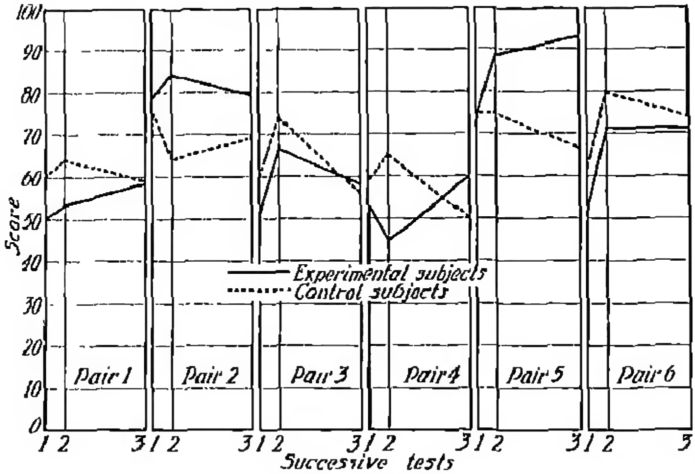

Figure 6. Matched pairs of girls compared for rhythm scores on initial test, retest, and final test.

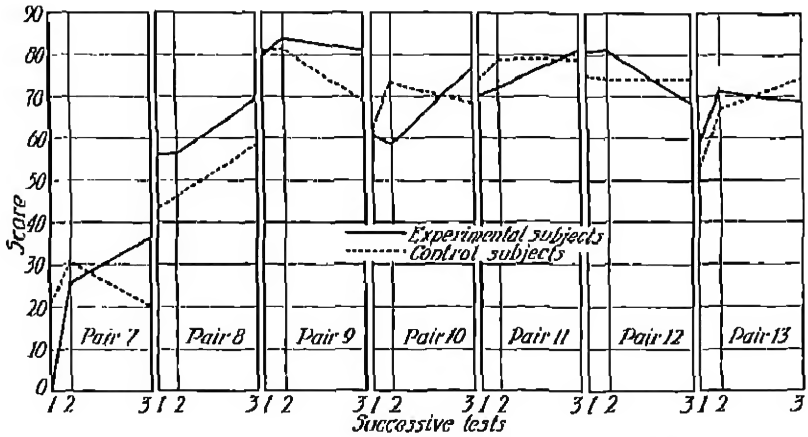

Figure 7. Matched pairs of boys compared for rhythm scores on initial test, retest, and final test.

records of the unmatched subjects.

Examination of Figures 6 and 7 shows that the advantage is with the experimental, or trained, member of the matched pair in ten cases; with the control, or untrained, member of the matched pair in two cases; while one pair shows no advantage for either member.

For the unmatched subjects (Figures 8 and 9), it will be seen that all five members of the experimental group show an upward trend from the retest to the final test, while only one of the four unmatched subjects in the control group shows this trend.

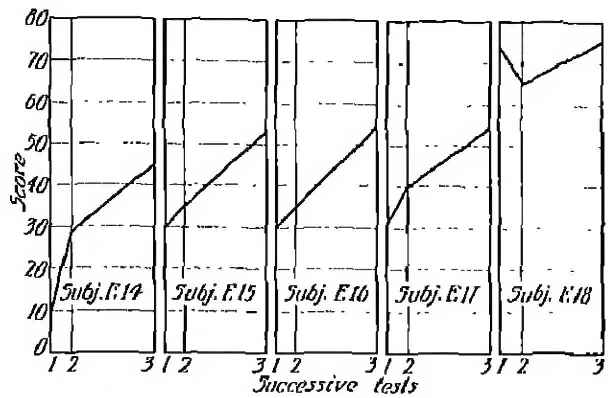

Figure 8. Unmatched experimental subjects - rhythm scores on initial test, retest, and final test.

Upon the consistency of the evidence, then, even though the groups are small and statistical reliability is not established, is based the proposition that rhythm, as tested in this investigation, is improved by general training in rhythmic activities.

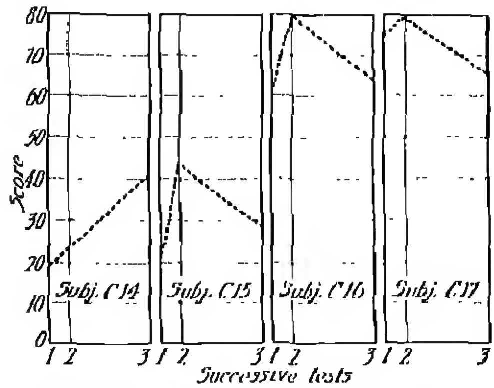

Figure 9. Unmatched control subjects - rhythm scores on initial test, retest, and final test.

Individual difference in rhythmization.--That there are individual differences in rhythmic ability is indicated in the distribution curve of the initial rhythm scores (Figure 1).

Comparison of Figures 1, 2, and 3 reveals differences in the forms of the three curves depicting rhythm, motor coordination, and strength of grip scores, respectively, with the rhythm curve skewed to the left, the motor coordination curve fairly normal and the strength curve skewed to the right. Distribution of the chronological age scores (see Figure 10) produces a curve more similar to that of the motor coordination scores than to either of the other two curves.

Thus, while rhythmization has been shown to be related to age, the difference between the shape of the distribution curve of initial rhythm scores and that of chronological age scores indicates the presence of other differentiation between individuals than that based upon age.

Consideration of a few individual records substantiates this conclusion. Two interesting cases among the younger children are Subjects E17 and E18, whose scores are shown in Figure 8.

Subject E17 is the youngest subject used in the study (57 months, or less than five years of age), yet her scores on the rhythm tests are comparable to those of several children a year or more older than she. She was even able to follow the more difficult Pattern III, which proved to be too complex for most of the younger children. Her behavior in the experimental situation was erratic, however. Much coaxing was necessary to persuade her to attempt the test at all, and even when she was giving a most creditable performance she was likely to stop and insist that "it's too hard." Equally distressing was her tendency to alternate hands in the course of a trial (she seemed to have no established hand preference), and finally she discovered considerable amusement in performing the rhythm pattern, without a break in rhythm, on adjacent keys rather than on the same key. These antics interfered with the smoothness of her performance and reduced her scores, since accuracy was an important element in scoring the tests, but they also showed the extent of her talent for rhythmizing. Many of the children could not have maintained the patterning at all, had they alternated hands or changed keys as did this child.

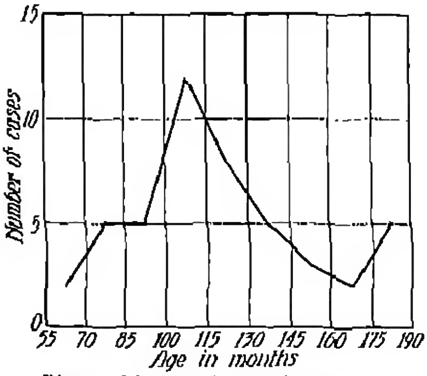

Figure 10. Distribution of chronological age scores of initial group of 47 children

The performance of Subject E18 on the rhythm test (see Figure 8) can be seen to compare favorably with all except the two most skillful of the subjects used in the training study, yet her age was only 74 months, or a little over six years. Her activity in the rhythm class was outstanding among the younger children, and her talent in this field had been noted by her kindergarten teacher.

Subject E14 is an example of unusually poor performance. This child, also a girl, was 9½ years of age at the time of the initial test, and has an IQ of 102, which is in the upper bracket for this group of children; yet her rhythmic ability, although she made great improvement or both the retest and the final test, is on a level with that of the youngest of the children.

Of particular interest from the medical standpoint is the performance of the two spastic subjects in the group. One of these was included in the matched pairs, as her disability is of a minor nature. Her record on the rhythm test is shown in Figure 6, where she is the experimental subject of Pair 4. It will be seen that her performance on the retest was not so good as that on the initial test, but her final performance, after training, showed definite improvement above her initial performance.

Subject E16 is a serious case of spastic paraplegia and it was not expected that she could perform adequately on this test. Her record, as shown in Figure 8, is on a level with that of Subjects E15 and E17, who are several years younger than she (her age was 124 months, or over 10 years, at the time of the initial

test). The significant thing in her case, however, is the fact that she made some improvement on the retest, and great improvement on the final test, after the training classes in which her activity was confined to use of the rhythm band instruments.

The improvement made by these two spastic subjects reinforces the theory that training in rhythmic muscular activity is useful for this disability.

Other interesting cases might be cited, but these suffice to show that, even at early age levels, differences in initial ability to rhythmize were found, as were also differences in response to training.

CONCLUSIONS

With certain qualifications pointed out in the body of this paper, the following conclusions seem justified on the basis of the findings of this study.

1. There are individual differences in ability to rhythmize.
2. Rhythmization and intelligence are both related to motor coordination.
3. Rhythmization is subject to improvement through both specific and general training, no matter what the initial level of ability may be.

RECOMMENDATIONS

In the light of the findings of this study, it would seem that the inclusion of training in rhythmic activities could be an important addition to the educational activities of an institution such as the one in which this investigation was carried out.

Most of the children in this group will have many difficulties to face in their efforts to adjust themselves to the physical and social environment in which they must move after leaving the comparative shelter of the Convalescent Home. To the extent, therefore, to which their motor coordinations can be improved, and their motor activities extended - to that extent will they be less odd in their home environment, and therefore less likely to become maladjusted there.

If ability to rhythmize is subject to improvement through training, and if rhythmization is a component in motor coordination, then much may be said in favor of a carefully planned program of activities beginning at the earliest possible age level, among physically normal as well as among physically handicapped children.

Too much of the physical activity of young children is left to incidental training, on the supposition that children will "naturally" run and skip and play and dance. Later, when high school boys and girls do none of these things, but, instead, are awkward and self-conscious in their motor coordinations, we glibly assign their difficulties to heredity, or, perhaps, to a temperamental idiosyncrasy, when, as a matter of fact, the temperamental traits might as easily be assigned to the motor difficulty as the motor difficulty to the temperament.

For the crippled child, a program of rhythmic activities, more or less similar to the one used during the training period of this study, would have a number of useful by-products in addition to the general objectives of improved motor coordination and enlarged sphere of motor activity.

Increased self-confidence and decreased self-consciousness with regard to the physical disability might well be the outcome for the little girl who finds she can dance a folk-dance, and the larger girl who learns a simple tap-dance when always before she has been told that "she couldn't expect to be able to dance."

Interest in music is inevitably fostered by the activities included in this type of program. Much of the first enthusiasm will favor the popular type of "swing" music, but permanent interest of a broader nature could well be developed from this nucleus.

Finally, the surprising improvement shown by the spastic subjects, particularly the more severe of the two cases, suggests that these activities might be an important addition to the physiotherapy program for spastic cases.

CHANGES IN BODY PROPORTIONS DURING INFANCY AND THE PRESCHOOL YEARS: I. THE THORACIC INDEX

HOWARD V. MEREDITH AND VIRGINIA B. KNOTT[1]

It is the purpose of this paper to report an investigation on the developmental course of the thoracic index during the postnatal period from three months to six years of age. The investigation includes (1) a review of previous research related to the problem, (2) an analysis of thoracic index distributions for successive quarterly or semiannual age intervals, (3) an examination of the relation between the trend for thoracic index and the growth patterns for the components of the index, and (4) some comparative findings for thoracic index and for the reciprocal form of this index.

According to a statement by Davenport (7, p. 3), Fourmentin was probably the first to use the term "thoracic index." Fourmentin, in 1874, defined the term as the percentage relation of the maximum transverse chest diameter to the maximum antero-posterior chest diameter. It is in this form - as the breadth of the thorax in percentage of the depth of the thorax - that the thoracic or chest index has been employed in studies on human embryos and fetuses by Müller (15) and by Schultz (19), and in studies on children of school age by Arsimoles and Du Courneau de Carritz (1) and by Davenport (7). Likewise in the present study, the term thoracic index will be used to symbolize the formula:

$$\frac{\text{Transverse Diameter of Thorax} \times 100}{\text{Antero-Posterior Diameter of Thorax}}$$

LITERATURE

Changes in the breadth-depth relationship of the external thorax during the prenatal and neonatal periods have been studied by Rodes (16), by Schultz (19), and by Scammon and Rucker (17).

Rodes (16) obtained thoracic measurements on four embryos and seven fetuses. The transverse diameter was measured at the widest point of the thorax and the antero-posterior diameter at the level of the xiphoid articulation in the mid-sagittal plane. The ratio of the latter measurement to the former was calculated for each of the eleven specimens. In reciprocal form, the resulting indices for the four embryos were 55.1 at approximately four weeks, 66.6 at five and one-half weeks, 77.9 at seven weeks, and 105.2 at ten weeks. Comparable indices for the one specimen representing the beginning of the fetal period (twelve weeks) and for one specimen representing the end of the fetal period (ten lunar months) were 109.9 and 113.6, respectively. Rodes' finding that the thorax of the young embryo is exceptionally narrow relative to its depth has been frequently commented upon as harmonizing with the fact that the heart of the embryo is relatively large and has a great antero-posterior diameter while the thoracic skeleton is relatively retarded in development.

[1] From Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

CHILD DEVELOPMENT, Vol. 9, No. 2 (June, 1938)

Schultz (19) studied a series of 623 human fetuses ranging in age from nine to forty menstrual weeks. The transverse and sagittal diameters of the thorax were measured at the level of the junction of the fourth pair of ribs with the sternum. In general, the thoracic index was found to increase "from an average of 104.6 at 9 weeks of fetal life to 118.4 at 12 weeks" and to remain at approximately the same figure from twelve weeks to the end of the fetal period. It will be noted that Schultz confirms the finding of Rodes that the breadth of the thorax equals about 1.05 times the depth of the thorax in the first half of the third prenatal month.

Scammon and Rucker (17) made a study of the changes in chest form between the close of the fetal period and the twelfth day of postnatal life. Their basic data consisted of transverse and antero-posterior measurements of the thorax taken both at the nipple level and at the level of the tenth ribs. Two series of subjects were used. The one series was fifty "late fetuses and full term still-born children" measured by Dr. L. A. Calkins, while the other was twenty-three living infants measured by the authors at the Minneapolis General Hospital. The latter series was measured fifteen minutes following birth, twelve hours later, on the third postnatal day, and (in part) on the fifth, seventh, tenth, and twelfth days after birth. Reduction of the data to index terms was accomplished "by dividing the antero-posterior diameter of the chest by the transverse diameter and multiplying the quotient by 100." (17, p. 559) At the nipple level, mean indices were obtained of 86.0 for full-term fetuses, 106.0 for living infants of fifteen minutes postnatal age, 102.0 for infants born twelve hours, and 100.5 for infants of five and twelve postnatal days. Taking the reciprocal[2] of each of these numbers (in order to derive indices of the form in which the thoracic index has been defined for purposes of the present investigation), the findings become 116.3, 94.3, 98.0, and 99.5, respectively. These findings indicate that the breadth of the thorax stands at about 116 per cent of thoracic depth at the close of intra-uterine life, that with the establishment of respiration (it) becomes greater in depth than in breadth, and that though the thorax becomes relatively flatter between the first and twelfth days of postnatal life its breadth does not equal its depth until sometime following the twelfth day. Scammon and Rucker cite evidence to show that these modifications in thoracic form are correlated with "the order and degree of expansion of the different parts of the lungs." (17, p. 564)

Synthesizing the foregoing research for the prenatal and neonatal periods, it may be stated:

1. That the thoracic index increases during the embryonic period from roughly 55 at four weeks, through 105 at nine or ten weeks, to 118 or less at twelve weeks

2. That the thoracic index remains at about 118 throughout the entire fetal period (While the figure from Scammon and Rucker for the close of the fetal period is around 116, these authors note that if corrected for the differential influence of injection of the fetuses

[2] Throughout this study, the decimal points of mathematical reciprocals are adjusted so as to give reciprocal indices a percentage relation analogous to the percentage relation of the original indices.

on the two chest dimensions this figure becomes somewhat higher.)

3. That the thoracic index decreases from 118 to 94 during the first fifteen minutes following birth

4. That the depth of the thorax exceeds the thoracic breadth during the second month of prenatal life and during at least the first twelve days of postnatal life

The trend of change in the external contour of the thorax during infancy and the preschool years has received but meagre study. Some findings are incorporated in publications by Scammon (18), Hrdlička (9), Gray and Ayres (8), Lucas and Pryor (13), and Weisman (21).

Scammon (18) reported on the thoracic form in the first year of postnatal life. His basic data were transverse and antero-posterior measurement values obtained on 600 normal infants, "25 of each sex for each month," by Dr. L. H. Richdorf. Observations were made both at the tenth rib level and at the level of the nipples. The sexes were not differentiated in analysis. At the level of the nipples, chest depth in percentage of chest width was found to descend from a mean of approximately 90 per cent at one month to 78 per cent at one year. At the level of the tenth ribs the descent was from 90 per cent to 85 per cent. Converted to figures for chest width in percentage of chest depth, the findings at the nipple level indicate a thoracic index trend which rises from 111 per cent at one month after birth to 128 per cent at one year of age. This trend implies that the mean breadth of the thorax exceeds the mean thoracic depth at one month of age and that the thorax becomes relatively broader during the first year of postnatal life.

Hrdlička (9), as a small fraction of an extensive study of white and colored asylum children of school age, obtained the ratio of chest depth to chest width for about thirty white children aged five and six years and twenty colored children aged three to six years. Measurements were taken "at the height of the nipples" with "a pair of accurate aluminum sliding compasses" (Hrdlicka compass). "In measuring, the branches of the compass were applied not simply to touch the skin but until they met with a marked resistance of the body." (9, p. 48) Taking the reciprocals of the ratios reported, the thoracic index for the subjects of three years is found to be 126 per cent in the case of a single colored male and 116 per cent for two colored females. Corresponding indices at five years of age are 133 for three colored males, 131 for four colored females, 136 for two white males, and 145 for two white females. Finally, the mean figures for thoracic index at six years are 132 for five colored males, 131 for two colored females, 136 for fifteen white males, and 137 for ten white females.

Gray and Ayres (8) published the results from a major investigation on Growth in Private School Children in 1931. Their monograph includes findings on chest form for children five and six years of age. Transverse chest diameter was measured at the level of the nipples and antero-posterior chest diameter at the same level anteriorly and just below the inferior angles of the scapulae posteriorly. Each diameter was taken with straight arm, sliding calipers and recorded as the median value during quiet breathing. The index calculated was that of antero-

posterior diameter in percentage of transverse diameter. At five years of age mean indices were obtained of 73.0 for forty-one males and 73.8 for twelve females. The mean indices for six years of age were 73.0 for eighty-six males and 75.0 for forty-two females. Translated into means for chest width in percentage of chest depth, these figures show chest width to approximate 136 per cent of chest depth at five years of age for both sexes. At six years of age the male width is 1.37 times depth and the female width 1.33 times depth.

Weisman (21) studied the thoracic contour for roughly 2,000 Minneapolis children aged five and six years. "The children were stripped to the waist, and the diameters of the chest were taken at the nipple line with an ordinary pelvimeter (curved calipers) with a scale graduated in centimeters." (21, p. 503) The measurements were made at some thirty schools in different parts of the city. From each pair of observations, Weisman calculated the ratio of the sagittal diameter of the thorax to the lateral thoracic diameter. Analysis by one-year age distributions gave means at five years of 72.0 per cent for 266 males and 71.0 per cent for 238 females, and at six years of 70.7 per cent for 784 males and 71.7 per cent for 733 females. In reciprocal form these figures become 138.9 and 141.4 for males and, for females, 140.8 and 139.5.

Standards for thirteen external dimensions of the body and six anthropometric indices, derived from measurements on about 6,000 "middle class, American-born, white" children between the ages of six months and sixteen years, were recently published by Lucas and Pryor (13). These standards include means for "antero-posterior thoracic diameter divided by transverse thoracic diameter" at nine months of age and at annual intervals from one and one-half to five and one-half years of age. The children were measured at San Francisco during the years 1930 to 1935. "Measurements of transverse chest were taken from the front with straight-arm calipers at the nipple level, the instrument being parallel to the floor." (13, p. 535) Measurements of antero-posterior diameter were made "with the spreading curved calipers at the junction of the fourth rib with the sternum," the instrument being parallel to the floor. All measurements were "done next to the skin" and all readings were "made during the middle phase of quiet respiration." The findings reported by these authors, together with the reciprocals of their means, are shown in the following tabulation:

Mean Age Years	Mean Age Months	Mean Index	Reciprocal
	Males		
	9	80.5	124.2
1	6	81.4	122.9
2	6	80.4	124.4
3	6	80.7	123.9
4	6	79.6	125.6
5	6	80.0	125.0
	Females		
	9	84.1	118.9
1	6	83.1	120.3
2	6	81.2	123.2
3	6	81.2	123.2
4	6	78.1	128.0
5	6	78.3	127.7

It will be noted that these indices indicate a distinctly lower order of relative thoracic breadth than that found at comparable ages by Scammon, Hrdlička, Gray and Ayres, or Weisman.

Summarizing the investigations for the infancy and preschool years, it may be stated:

1. That the thoracic index stands at about 111 at one month of age (Scammon)

2. That the thoracic index increases rapidly between one month and one year of age. According to Scammon the index approximates 126 by the end of the first postnatal year. According to Lucas and Pryor the index for this age is about 124 for males and 119 for females.

3. That the trend of the thoracic index between one and six years of age is not established. The studies of Hrdlička, Gray and Ayres, and Weisman imply a rising trend with an index for six years of 135 to 140. Lucas and Pryor, on the contrary, find no rise in the trend for males and a rise to a markedly lower level in the trend for females. Their study shows the thoracic index for the sixth year to stand at 125 for males and 128 for females.

4. That there is need for additional and more exhaustive study of the developmental trend for the thoracic index throughout the infancy and preschool years

Studies dealing with the form of the thorax in subjects beyond the age of six years have been reported by Davenport (7), Gray and Ayres (8), Hrdlička (9, 10), Lucas and Pryor (13), Rodes (16), and Weisman (21, 22, 23, 24). Only the salient findings from each of these studies will be reviewed. The mean indices given in the reports, where necessary, will be converted to transverse diameter of the thorax in percentage of antero-posterior diameter. With two exceptions, the methods and material upon which each of the reports is based have been described previously. This information will not be repeated.

Davenport (7) studied the trend of the thoracic index during childhood and adolescence for two groups of subjects. One group was from the Orphan Asylum of Brooklyn and the other from the Letchworth Village Development, a New York institution for the feeble-minded. The lateral diameter of the thorax was taken "holding the anthropometer rod at the level of the nipples in front, letting the arms of the rod fall across the widest part of the thorax in the vicinity of the 6th or 7th rib." (7, p. 1-2) The sagittal diameter was measured perpendicularly to the long axis of the vertebral column at the level of the nipples - straight arm calipers being used with younger children and curved arms on the upper section of the anthropometer rod with older children. For the age interval from roughly six to sixteen years, the mean thoracic index was found to fluctuate between 132 and 135 for Brooklyn Asylum females, between 130 and 135 for Brooklyn Asylum males, and between 127 and 130 for Letchworth Village males. Besides these gross findings. Davenport presents mean curves for American "Negro," Nordic, and Mediterranean

children of the Letchworth Village population; illustrates different types of index curves for the individual; and discusses the phylogeny of man's thoracic index. Unfortunately, no mention is made of the number of observations employed in the study, and tabular presentation of the findings is entirely lacking.

In contrast to Davenport's study, the study by Weisman (21) is shown to be based on an adequate sample of over 17,000 Minneapolis school children. For males, the mean thoracic index is here found to increase slowly and steadily from 139 at seven years of age to nearly 148 at seventeen years. For females, the increase during the same age period is from 141 to 147. Weisman (22, 23, 24) subsequently analyzed portions of the data with a view to revealing socio-economic and racial differences for thoracic index. He found (1) that children attending schools in the best districts of Minneapolis had less rounded, relatively broader chests than children attending schools in the poorest districts, and (2) that Minneapolis school children of Scandinavian, German, Russian, and Jewish nationality groups "resembled each other closely" in average contour of the chest.

The mean thoracic indices obtained by Hrdlička (9) for white asylum males rise from 139 at seven years to 147 at seventeen years. This trend closely follows the findings of Weisman for his total male sample. Corresponding means for white asylum females indicate a gradually increasing index from 143 at seven years to 146 at eleven years with marked fluctuations thereafter. On comparing mean indices and mean chest dimensions for white and colored asylum children of like age and sex, Hrdlička found a "somewhat deeper character of the chest in the negro children." (9, p. 49)

Gray and Ayres (8) found a less pronounced rise in the mean curve of thoracic index than that reported by Weisman and by Hrdlička. For males, their index rises slowly from 138 at seven years to 141 at seventeen years. For females there is an increase of only 1 per cent - from 133 at seven years to 134 at seventeen years.

The indices reported by Lucas and Pryor (13) differ markedly from those obtained by other investigators in that they give a highly irregular trend from age to age. The mean male index for the sixth year is approximately 127. From the sixth to the thirteenth years the index fluctuates between 127 and 133. At the fourteenth year it drops to 126, and the following year rises to over 136. In the case of females the mean index increases somewhat erratically from 128 for the sixth year to 144 for the thirteenth year, falls to 126 for the following year, and then rises to 137 for the fifteenth year.

Investigations on the thoracic index in the adult have been made by Rodes (18) and Hrdlička (10). Rodes obtained mean indices of 137 for fifty young white women and 141 for forty-eight young colored women. He concluded that the thorax of colored women is relatively flatter than the thorax of white women.

Hrdlička (10) studied the chest form for over four hundred "Old American" adults, mainly residents of Washington, D. C. The transverse and sagittal measurements were recorded as "the mean between inspiration and expiration" obtained with the "broad-branched calipers" at "the level of the nipples in men and at the

corresponding one of the upper border of the fourth costal cartilages in the women." (10, p. 305) The mean findings for thoracic index were 133 for 175 women and 137 for 246 men. Analysis of the sex difference yielded the following: "In depth the female chest stands to that of the male as 92.3 (to 100), in breadth as 89.4 (to 100)...As the stature relation between the two sexes is as 92.8 to 100....it must be concluded that....(there) is a relative narrowness of the chest in the females." (10, p. 306) Finally, Hrdlička obtained average indices for his twenty-five youngest cases of each sex and his twenty-five oldest cases of each sex. These were 135 and 128 for the women, 141 and 130 for the men. It was concluded: "Remarkable and unexpected differences in the chest appear when our data are analysed as to age. It not only becomes evident that the chest increases in size with age after supposedly full growth has been reached, but also that it increases unevenly. It grows during adult life moderately in breadth, but more markedly in depth, particularly so in the males, thus reversing the conditions during childhood and adolescence. The chest in the young adults is flatter than in those after fifty...." (10, p. 306)

DATA

The original data of the present investigation consist of 2,037 paired measurements for width and depth of the thorax on 557 males and 1,631 paired measurements for like dimensions of the thorax on 448 females. These data were obtained from physical measurement records made at the University of Iowa infant laboratory, preschool laboratories, and elementary school. They represent observations accumulated on Iowa City children during the years 1929 to 1936 by the anthropometric staff of the Iowa Child Welfare Research Station.

Each record was taken from the files in serial order and accepted for tabulation provided (1) that it fell between the age limits of one and one-half months and six years, two months, thirty days, (2) that it carried paired values for transverse and antero-posterior diameters of the thorax taken at the level of the ensiform or xiphoid cartilage, and (3) that it was not marked as applying either to an individual of Negroid, Mongoloid, Jewish, or southwest European stock, or to an individual considered to lie outside the normal zone for physical build.

Detailed information on country of birth of the parents and grandparents and on the occupation of the father was available for approximately 50 per cent of the subjects. Analysis of this material yielded the following findings:

1. Both parents for approximately 92 per cent of the subjects were born in the United States.

2. For around 55 per cent of the subjects, the parents and four grandparents were all born in the United States.

3. Roughly 31 per cent of the fathers were professional people, an additional 24 per cent were business proprietors, managers, or salesmen. Four per cent only were day laborers, and the remaining 41 per cent were about evenly divided between skilled trade employees, clerks and carriers, and students.

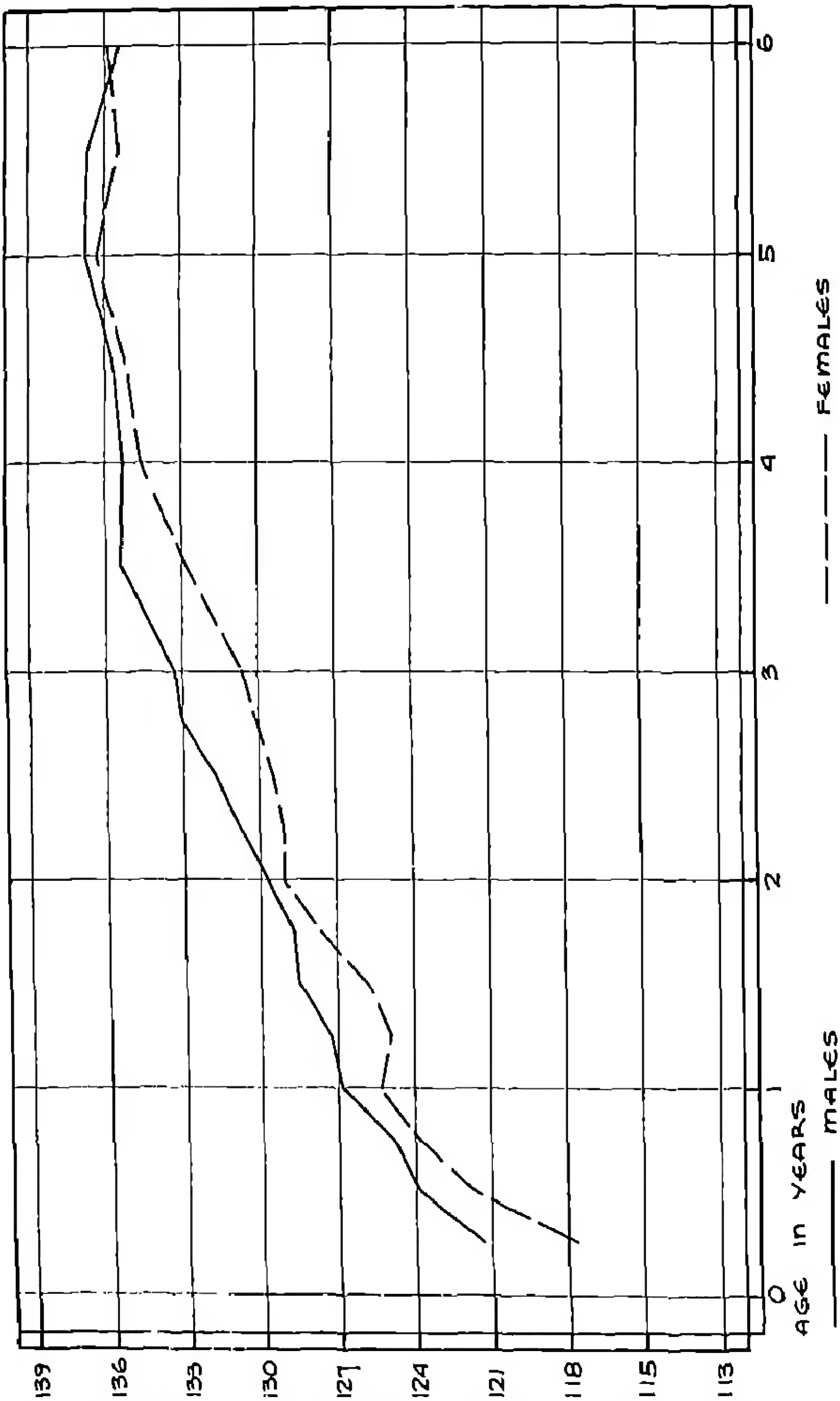

Figure 1. Thoracic Index Curves: Drawn to Mean Values Given in Table 1.

The sample as a whole may be summarily characterized as being homogeneous with respect to geographic location, consisting of American-born children of northwest European ancestry, and representing a population that is heavily weighted with the professional and managerial classes.

As indicated in the introduction of this paper, the thoracic index is:

$$\frac{\text{Transverse Diameter of Thorax x 100}}{\text{Antero-Posterior Diameter of Thorax}}$$

With reference to our original data, this formula was applied to transverse and antero-posterior measurements made at the level of the xiphisternal junction wit the large, straight arm, sliding calipers (Hrdlička compass).

THE THORACIC INDEX

Thoracic index values were computed from each pair of thoracic measurements. These derived values were then grouped into thirty-six distributions, eighteen for males and eighteen for females. In the case of each sex, eleven distributions covered the successive quarter-year intervals from one month, fifteen days to two years, ten months, fourteen days while the remaining seven distributions covered the consecutive half-year intervals from two years, nine months to six years, two months, thirty days. The results from analysis of these distributions are given in Table 1. Figure 1 shows curves of thoracic index drawn to the mean indices for males and females. Inspection of this table and graph yields the following findings:

1. *There is an increase in mean thoracic index for both sexes during the age* period from three months to five years. The increase is from 121.4 to 136.0 for males and from 117.7 to 136.4 for females. It follows, then, that the transverse diameter of the thorax is found to be relatively broader at five years of age than at the age of three months by 15.4 per cent and 18.7 per cent for males and females, respectively.

2. The increase in mean thoracic index is greater between three months of age and two years of age than during any similar age interval which follows. Relative to its antero-posterior diameter, the thorax of males is 9.3 per cent broader at two years than at three months and only 5.5 per cent broader at four years than at two years. The corresponding percentages for relative broadening in females are 11.3 and 5.6. Within this period of rapid increase, greater gain is made between three months and one year of age than during the second year.

3. During the sixth year both males and females show a minor decrease in mean thoracic index. The mean indices obtained for the end of the sixth year are 135.5 for males and 135.9 for females.

4. Males exceed females in mean thoracic index throughout the entire age period studied except at six years. From three months to four years of age the male means are markedly higher than the female means, from four to five and one-half years the differences are less pronounced, and at six years the female mean is

TABLE 1

THORACIC INDEX: TRANSVERSE DIAMETER OF THORAX AT LEVEL OF XIPHOID CARTILAGE IN PERCENTAGE OF ANTERO-POSTERIOR DIAMETER OF THORAX AT SAME LEVEL*

Mean Age Year	Mean Age Month	Cases	Mean	Standard Error of Mean	Standard Deviation	Range
Males						
	3	65	121.4	1.15	9.30	106 to 145
	6	109	123.9	.80	8.37	106 to 145
	9	136	124.8	.74	8.59	101 to 153
1	0	152	126.9	.72	8.82	108 to 146
1	3	141	127.2	.80	9.46	103 to 154
1	6	118	128.5	.74	8.04	110 to 149
1	9	103	128.7	.82	8.37	111 to 153
2	0	109	129.7	.83	8.70	114 to 150
2	3	101	130.8	.82	8.25	113 to 165
2	6	94	131.8	.90	8.73	116 to 162
2	9	97	133.0	.87	8.54	114 to 160
3	0	122	133.3	.72	7.91	114 to 151
3	6	119	135.4	.67	7.35	113 to 153
4	0	113	135.2	.77	8.21	115 to 154
4	6	109	135.7	.79	8.23	113 to 159
5	0	116	136.8	.82	8.80	112 to 160
5	6	122	130.7	.76	8.25	116 to 162
6	0	111	135.5	.81	8.59	113 to 161
Females						
	3	61	117.7	1.13	8.10	103 to 137
	6	108	121.7	.76	7.69	104 to 137
	9	117	123.9	.66	7.14	109 to 141
1	0	119	125.3	.67	7.34	110 to 143
1	3	108	125.0	.56	5.87	111 to 140
1	6	98	125.8	.64	6.38	113 to 142
1	9	87	127.6	.81	7.58	110 to 144
2	0	74	129.0	.78	6.69	111 to 143
2	3	81	129.0	.82	7.35	111 to 147
2	6	71	129.4	.76	6.43	114 to 145
2	9	70	130.1	.87	7.28	111 to 146
3	0	71	130.7	.91	7.68	113 to 147
3	6	83	132.9	.68	6.17	120 to 148
4	0	87	134.8	.78	7.26	118 to 150
4	6	97	135.2	.73	7.18	118 to 151
5	0	109	136.4	.67	6.97	120 to 153
5	6	104	135.5	.66	6.75	121 to 161
6	0	98	135.9	.70	6.89	119 to 155

* The basic data are measurement values for Iowa City males and females of northwest European descent.

slightly higher than the male mean. It is thus found that the male thorax is relatively broader than the female thorax below four years of age, but that sex differences become minimized from four to six years of age.

5. Variability in thoracic index, as measured by the standard deviation, shows no consistent trend either toward increase or decrease during the period from six months to six years. Though age differences are negligible, however, there is a systematic sex difference such that the average of the standard deviations between six months and six years is 8.4 for males and 7.0 for females. A zone of one standard deviation above and below the means for two years of age would thus include all male indices from 121.3 to 139.1 and all female indices with the limits of 122.0 to 136.0.

6. There is almost complete overlapping of the distributions for a given sex at successive ages. This may be illustrated by comparative findings obtained on use of the extreme distributions for males as points of reference. It will be noted that the range for males at three months of age is from 106 to 145. The upper limit of this range is exceeded by only 4.6 per cent of the cases at two years and by only 12.6 per cent of the cases at six years. Conversely, the range at the age of six years is from 113 to 161. No case falls below the lower limit of this range at two years, and only 20 per cent of the cases at three months have an index lower than 113.

THE COMPONENTS OF THORACIC INDEX

In the previous section it was shown that mean thoracic index increases during the period extending from three months of age to at least five years of age. This increasing index was interpreted as indicating that the transverse diameter of the thorax gradually becomes broader in relation to the sagittal diameter. No attempt was made, however, to elucidate the growth patterns which merge to give the rising index as their composite resultant. Obviously, the rising index - and the relative thoracic broadening which it implies - may be due (1) to increase of chest width in the absence of increase in chest depth, (2) to absence of increase in chest width with a decrease in chest depth, (3) to more rapid rate of increase in chest width than in chest depth, or (4) to some combination of these relationships.

It is the purpose of this section to make a separate analysis for each component of the thoracic index and thereby to reveal the growth relationships which are compounded in the trend of the index during infancy and the preschool years.

Findings obtained from statistical reduction of our male[3] data for width and depth of the thorax are given in Table 2. This table shows:

1. The mean transverse diameter of the thorax increases from 13.25 cm. at the age of three months to 18.75 cm. at six years of age. This is an increase of 5.5 cm. or 41.5 per cent of mean size at three months. According to Boynton (5, p. 22), the increase for females is 5.7 cm. or 45.8 per cent, the mean at three months being 12.45 cm. and at six years 18.15 cm.

2. There is an increase in mean antero-posterior diameter of the thorax from 10.95 cm. at age three months to 13.87 cm. at age six years. With reference to the mean at three months, this increase amounts to 2.92 cm. or 26.7 per cent. Boynton's means for females are 10.46 at three months and 13.15 at six years (5, p.23). The female increase on mean size at three months is thus shown to be 2.69 cm. or 25.7 per cent.

3. Between two and three years of age the antero-posterior diameter of the thorax remains almost stationary in mean size. The mean at two years is 12.95 cm. and at three years 13.05 cm., the difference being one-tenth of a centimeter. Comparable means for females, from Boynton, are 12.43 and 12.46, respectively.

[3] A similar analysis of female data for each of these thoracic dimensions has been previously reported by Boynton (5).

TABLE 2

THORACIC DIMENSIONS (CENTIMETERS): MEAN, STANDARD ERROR OF MEAN, STANDARD DEVIATION, AND RANGE VALUES*

Mean Age Year	Mean Age Month	Cases	Mean	Standard Error of Mean	Standard Deviation	Range
		Transverse Diameter				
	3	65	13.25	.13	1.05	11.3 to 15.6
	6	109	14.44	.08	.83	11.9 to 16.3
	9	136	14.96	.07	.82	12.9 to 16.6
1	0	152	15.69	.06	.76	14.0 to 18.0
1	3	141	15.96	.07	.85	13.9 to 18.4
1	6	118	16.25	.07	.78	14.2 to 18.6
1	9	103	16.48	.07	.74	14.7 to 18.3
2	0	109	16.73	.07	.75	14.8 to 19.0
2	3	101	16.87	.08	.76	15.0 to 19.2
2	6	94	17.07	.09	.87	15.2 to 19.2
2	9	97	17.21	.09	.92	15.0 to 19.6
3	0	122	17.36	.08	.88	15.2 to 19.4
3	6	119	17.60	.08	.83	15.5 to 19.5
4	0	113	17.92	.08	.90	15.8 to 20.4
4	6	109	18.10	.08	.82	16.2 to 20.1
5	0	116	18.36	.08	.88	16.4 to 20.6
5	6	122	18.53	.08	.95	16.5 to 21.0
6	0	111	18.75	.11	1.12	16.4 to 21.5
		Antero-Posterior Diameter				
	3	65	10.95	.10	.79	9.4 to 12.4
	6	109	11.68	.06	.67	10.0 to 13.2
	9	136	12.03	.07	.85	10.1 to 14.2
1	0	152	12.33	.07	.92	10.2 to 15.2
1	3	141	12.59	.08	.94	10.8 to 15.0
1	6	118	12.68	.08	.82	11.0 to 15.1
1	9	103	12.84	.08	.84	10.9 to 15.0
2	0	109	12.95	.09	.91	10.9 to 15.1
2	3	101	12.94	.08	.85	10.9 to 14.8
2	6	94	12.99	.09	.90	11.2 to 15.0
2	9	97	12.97	.09	.84	10.9 to 14.9
3	0	122	13.05	.08	.83	10.9 to 15.3
3	6	119	13.03	.07	.73	11.3 to 15.2
4	0	113	13.28	.07	.76	11.2 to 14.9
4	6	109	13.37	.08	.79	11.7 to 15.0
5	0	118	13.48	.08	.83	11.8 to 15.6
5	6	122	13.59	.07	.81	11.5 to 15.4
6	0	111	13.87	.09	.90	11.6 to 15.8

* Basic data are transverse and antero-posterior measurements at the xiphoid level for Iowa City white males.

It follows from these findings that the rising thoracic index between three months and five years of age is due, in the main, to increase in transverse diameter in the absence of increase in sagittal diameter during the third year and to more rapid rate of increase in transverse diameter than in sagittal diameter during the age spans before and following the third year.

CHANGES IN THORACIC INDEX IN RELATION TO RATES OF GROWTH FOR THE COMPONENTS OF THORACIC INDEX

A more detailed study of the relation between the growth patterns for each of the components of the thoracic index and the age trend for the index itself may be made by the use of Figure 2 in conjunction with Figure 1.

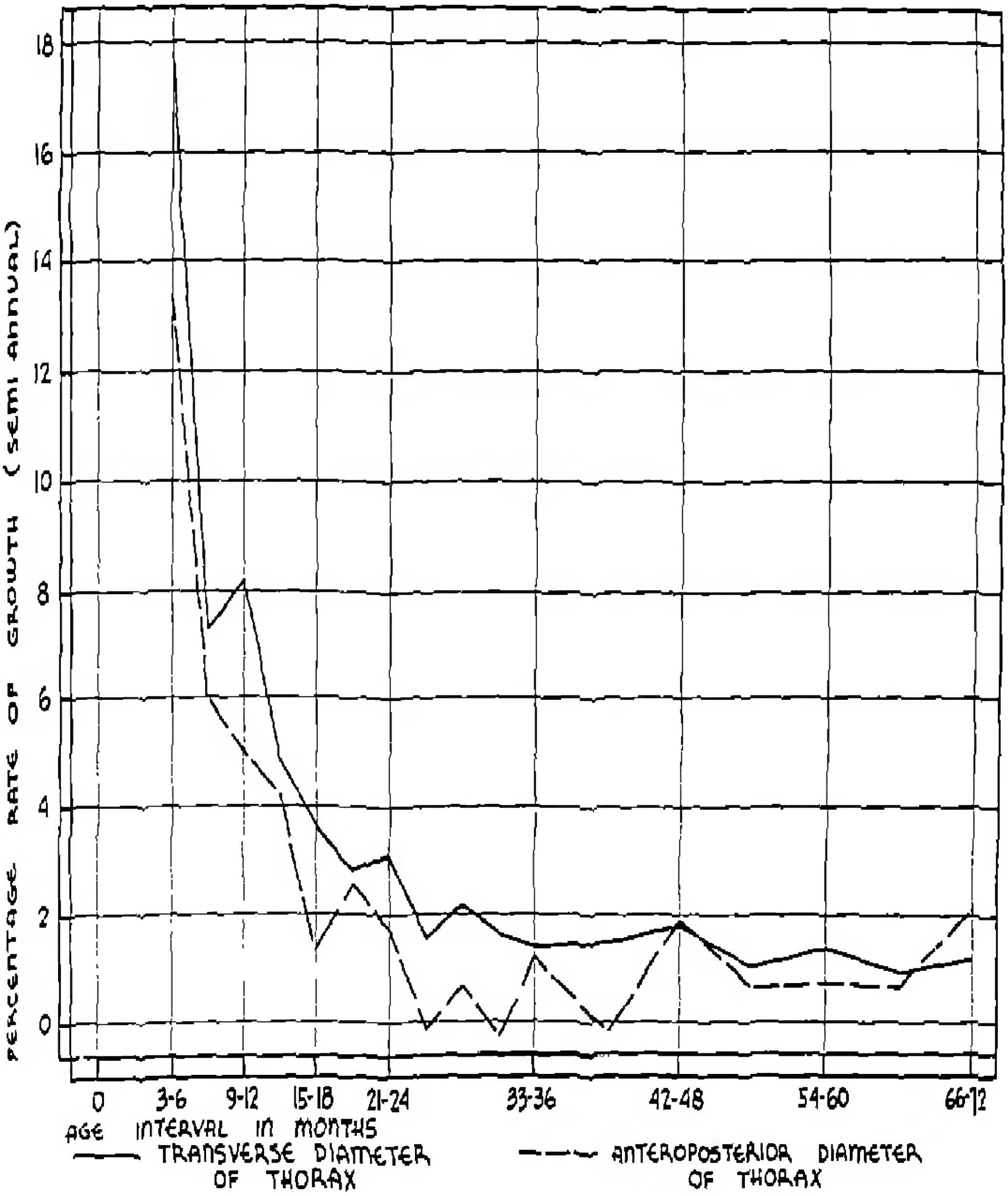

Figure 2. Relative Increment Curves: Semiannual Percentage Rates of Growth Derived from the Means for Males Given in Table 2.

Figure 2 gives the percentage increment curves, in semiannual terms, for width and depth of the male thorax. The percentage rate values to which these curves are plotted were derived from the series of means in Table 2 by use of Minot's arithmetic formula. This formula requires, for example, that in order to find the percentage increment in thoracic width between five and one-half and six years of age, one obtains the difference between 18.53 and 18.75 (Table 2) and divides this difference by 18.53. The result is an increment for the half-year interval of 1.2 per cent. Below three years of age the percentage rates were obtained for quarterly intervals and then multiplied by two to convert them to semiannual terms. With all increment values thus expressed in like form, it was possible to plot them on a single graph.

Figure 2 shows:

1. The percentage rate of growth for antero-posterior diameter of the thorax only exceeds the percentage rate of growth for transverse diameter for the two age intervals three and one-half to four years and five and one-half to six years. Reference to the curve for males in Figure 1 yields the parallel finding that at four and six years respectively there are reversals or setbacks in the rising trend of thoracic index. While in the earlier instance the relative broadening of the thorax is negligible, at the later age the decrease in index is from 136.7 at five and one-half years to 135.5 at six years.

2. The percentage rates of growth for transverse and antero-posterior diameters of the thorax closely approximate each other for the age intervals one and one-half to one and three-fourths years and two and three-fourths to three years. The semiannual rates for the former interval of 2.8 per cent in chest width and 2.6 per cent in chest depth are paralleled by an exceptionally slight rise in thoracic index from 128.5 at one and one-half years to 128.7 at one and three-fourths years. For the latter interval, the semiannual rates of increment of 1.4 per cent and 1.2 per cent are likewise paralleled by a minor rise in thoracic index from 133.0 at two and three-fourths years to 133.3 at three years.

3. The age intervals at which the transverse and antero-posterior percentage rate curves diverge most widely from each other are the age intervals at which the thoracic index rises most abruptly. From three to six months of age, for instance, the semiannual increase rate is approximately 4.5 per cent higher for chest width than for chest depth, and the thoracic index increases from 121.4 to 123.9.

In reporting these findings it is not the intention of the authors to imply that either the irregularities in the rising curves of Figure 1 or the fluctuations in the descending curves of Figure 2 are biologically significant. The objective in this section has been to illustrate, by means of the particular sample under study, the synchronous relationship between changes in thoracic index and percentage rates of growth for the two components of the index.

MEAN THORACIC INDEX COMPARED WITH THE RATIO OF MEAN CHEST BREADTH TO MEAN CHEST DEPTH

Several investigators, concerned with the study of growth in bodily dimensions

rather than with age changes in bodily proportions, have published means for both the transverse and the antero-posterior diameter of the thorax at various ages during the infant and preschool years. American studies reporting such means are those by Baldwin and Stecher (2), Baldwin, Fillmore, and Hadley (3), Bayley and Davis (4), Boynton (5), Crum (6), Iowa Child Welfare Research Station (11, 12), Meredith (14), and Schwartz, Britton, and Thompson (20). Given a knowledge of the relationship between mean thoracic index and the ratio of mean transverse diameter to mean antero-posterior diameter, the paired series of means from each of these studies could be used for comparative purposes by those interested in the thoracic index during the infancy and preschool period.

Table 3 presents, for the male data employed in this paper, a comparison of mean thoracic index and the ratio of mean chest width to mean chest depth. The column of this table headed "Index Minus Ratio" shows that during the age period from three months to six years the mean thoracic index is consistently higher by .2 to .5 per cent than the ratio of mean thoracic width to mean thoracic depth. It may be concluded, therefore, that for the age interval covered by this study (1) there is a systematic difference between mean thoracic index and the quotient for chest width divided by chest depth, but (2) this difference is sufficiently small so that in comparing the findings by the one method on one sample and by the other method on another sample it may usually be disregarded.

TABLE 3

MEAN THORACIC INDEX COMPARED WITH RATIO FOR MEAN CHEST WIDTH IN PERCENTAGE OF MEAN CHEST DEPTH (MALE DATA)

Mean Age		Cases	Thoracic Index	Ratio of Thoracic Means	Index Minus Ratio
Year	Month				
	3	65	121.4	121.0	.4
	6	109	123.9	123.6	.3
	9	136	124.8	124.4	.4
1	0	152	126.9	126.4	.5
1	3	141	127.2	126.8	.4
1	6	118	128.5	128.2	.3
1	9	103	128.7	128.3	.4
2	0	109	129.7	129.2	.5
2	3	101	130.8	130.4	.4
2	6	94	131.8	131.4	.4
2	9	97	133.0	132.7	.3
3	0	122	133.3	133.0	.3
3	6	119	135.4	135.1	.3
4	0	113	135.2	134.9	.3
4	6	109	135.7	135.4	.3
5	0	116	136.8	136.3	.5
5	6	122	136.7	136.5	.2
6	0	111	135.5	135.2	.3

THE RECIPROCAL OF THORACIC INDEX

Many investigators and clinicians are accustomed to expressing the relationship between thoracic breadth and thoracic depth in terms of the ratio of the latter to the former. For the convenience of these workers it was decided to compute indices of the form

$$\frac{\text{Antero-Posterior Diameter of Thorax x 100}}{\text{Transverse Diameter of Thorax}}$$

for each of the 3,668 pairs of measurements included in the original data of this study. As in the case of the thoracic index values, these values for the reciprocal of thoracic index were grouped into thirty-six distributions (eighteen for each sex) and the mean of each distribution obtained. The results are given in Table 4.

TABLE 4

RECIPROCAL OF THORACIC INDEX: MEAN PER CENTS FOR IOWA CITY MALES AND FEMALES OF NORTHWEST EUROPEAN DESCENT

Mean Age		Males		Females	
Year	Month	Cases	Mean	Cases	Mean
	3	65	82.9	51	85.3
	6	109	81.0	106	82.5
	9	136	80.4	117	80.9
1	0	152	79.2	119	80.1
1	3	141	79.0	108	80.2
1	6	118	78.1	98	79.7
1	9	103	78.0	87	78.6
2	0	109	77.5	74	77.7
2	3	101	76.5	81	77.8
2	6	94	76.2	71	77.5
2	9	97	75.5	70	77.0
3	0	122	75.2	71	76.8
3	6	119	74.1	83	75.4
4	0	113	74.3	87	74.5
4	6	109	74.0	97	74.2
5	0	116	73.4	109	73.5
5	6	122	73.4	104	74.0
6	0	111	74.1	90	73.8

The means in Table 4 are not, of course, identical with the reciprocals of the means in Table 1. However, the differences are found to be small and to be consistently in the direction of the former being larger than the latter. In this connection it appears pertinent to call attention to the fact that, for the data under analysis, the reciprocals of means and the ratios of one mean to another are always smaller than mean indices derived directly from index numbers for each pair of measurements. That is, the ratio of $\frac{\text{Mean Chest Width}}{\text{Mean Chest Depth}}$ is less than the mean of $\frac{\text{Width}}{\text{Depth}}$, the ratio of $\frac{\text{Mean Chest Depth}}{\text{Mean Chest Width}}$ is less than the mean of $\frac{\text{Depth}}{\text{Width}}$, the reciprocal of mean of $\frac{\text{Width}}{\text{Depth}}$ is less than the mean of $\frac{\text{Depth}}{\text{Width}}$, the reciprocal of mean of $\frac{\text{Depth}}{\text{Width}}$ is less than the mean of $\frac{\text{Width}}{\text{Depth}}$. In no case is the difference greater than

.8 per cent, while the average difference approximates .4 per cent. (See, for example, Table 3).

SUMMARY

The major portion of this study is concerned with an analysis of thoracic index values for males and females in the infancy and preschool age periods. These values are computed as the percentage relation of chest breadth to chest depth and are derived from around 3,500 paired thoracic measurements taken on approximately 1,000 Iowa City children of northwest European ancestry.

Secondary consideration is given to the concomitant variations in the growth rates for the transverse and antero-posterior dimensions of the thorax. Means for the reciprocal of thoracic index are also presented.

A review is made of the research literature on the thoracic index. This includes findings with reference to the developmental trend for the index not only throughout infancy and the preschool years but also during prenatal life and between childhood and adulthood.

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TEACHING THE PRESCHOOL CHILD TO REASON

ENID S. SMITH [1]

The desire of the child to understand the cause of what he sees as effects or results is brought out in the numerous questions he asks, such as "How does green grass make white milk? Why doesn't my stomach have teeth? Will tomorrow be yesterday some time? Is bones the lattice work on my body? Where was I before I was borned? Is there rubber in my spine so I can bend down and pick up my things? Why does God put on the darkness at night? Is it because Joe ate pickles that he's cross at me?" These, and hundreds of other questions, indicate the desire to get at the causes back of effects. This phase of the child's thinking should be encouraged. It will solve many behavior problems. For example, when Bobby ran against the table, bumped his head, and began to pummel the table, it was appropriate to question him thus: "Was it the table that made you bump your head? Were you running through the room not looking where you were going?" After a moment's thought, he drew his own conclusions: "Why, mother, I bumped my own head--the table didn't bump me--I bumped the table. I do not want to bump my head. If I look where I am going I will not bump my head any more."

Bobby had just been given boards, a hammer, and nails, and told he might make himself some playthings. His mother was weeding the garden. He asked: "Mother, are you helping the plants to make themselves?" "Yes, Bobby, I'm helping the flowers to grow, but just what do you mean by helping the plants to make themselves?" The pre-school child was silent a moment, and then he answered: "Well, you're helping the plants like God helps the alligator pear tree to make itself. God puts the sun out to shine, and tells the clouds to let down the rain, and says to the tree, 'Now you got things to make things out of, so you make your own leaves and your own pears out of the sunshine I give you, and the water, and the fresh air, and the dirt.'"

Just so, the child indicates that he is beginning to grasp the idea of process or of continuity, without which he could never really comprehend life. Into this constructive view of life the little child may be led as naturally and as healthfully as into the realization that he breathes, or that he has brothers and sisters. Education should help him to see in the effect a cause; or in other words, he is to be taught to become a rational being.

The mother or teacher can give the preschool child much more logical training than is often done. A beginning of this type of training was made with the four-year old son of the writer, who is a teacher and a mother. Bobby demonstrated his ability to analyze a situation and to make reasonable adaptations when his mother was detained one day at school past the noon hour. He knew that there was little in the house to eat, but that mother intended to return with food for lunch. He also understood that he could take any of his problems to the next door neighbor whenever he wished to do so. But he chose to act independently. No mother, no lunch was sufficient motivation for action. He quickly climbed the alligator pear

[1] From Bethel College, Newton, Kansas.

CHILD DEVELOPMENT, Vol. 8, No. 2 (June, [illegible])

tree in the back yard, plucked two huge pears, went down to the street corner, stood a few moments advertising a sale on alligator pears--two for a dime--presently sold them, then with the money thus obtained purchased, at the corner grocery store, a pint of milk and a small loaf of bread. Returning home he set the table and was happily eating his lunch when mother arrived upon the scene. "I thought you had to stay at school and help some of those children of yours," he remarked, unconcernedly, "so I just made my own dinner. You always told me to use my head. I used my feet too. I knew you didn't care if I climbed the tree and got a couple of pears, 'cause there's lots of baby pears growing bigger every day."

As far as consistent with his well-being the child should live in a real world of problems similar to the situations he will later encounter where he will need to figure out things for himself, stand upon his own decisions, and fight his own battles. He should be able to see in human relationships the causes of such results as unfriendliness, selfishness, inequality; to have special training in the art of living.

The tracing of faults in children back to their causes helps much in rooting them out. As an example of this, the writer's little daughter, whom we will call Betty, came crying to the house one day looking for sympathy. She had quarreled with her next door neighbor, Annie. "Annie won't play with me any more, mother. I haven't anybody to play with," she sobbed. Then mother asked the following questions: "Can you just think a moment what caused her to leave you? Were you kind and generous to her?" Betty hung her head, as she replied, "I wouldn't let her play with the new dress I made my doll, and I didn't want her to put my dollie to sleep all the time. Annie started to cry and I said 'If you're going to be a cry baby, well you can go back to your own yard, 'cause our flowers won't grow well in salt tears you're shedding all around here.'" "Well, what do you think you can do to make Annie happy again?" she was asked. Betty's face brightened, "I could make her a doll dress for her very own like the one I have, and I could let her play with my sleepy doll, and we could play in my doll-house. Do you think that would make her happy?" she asked. "You might try", it was suggested. The plan worked out well, for Betty had learned something about analyzing a situation to find the cause of an unpleasant effect, and then she had set about starting a cause that would give the desired effect.

One little preschool child was able not only to trace back physical aches, but irritated moods to disordered stomach aches. "Do you suppose, mother, that why Tommie was so cross to all the children today was because he had eaten lots of vinegar or pickles or pepper?" he asked.

The child who has been taught to understand causes and effects sees readily that his discomfiture or his disgrace is merely the natural consequence of his deed, and he usually accepts it without rebellion or a revengeful thought. It is Nature's way of teaching the child who puts out his hand and touches a hot radiator. No whirlwind of force rushes forward and whisks him away from the natural consequence of being burned. Bobby's brother, whom we will call Billy, may be used in way of illustration. When he asked to be allowed, for a week, to manage the wearing of his supply of clean blouses, he was reminded that on Friday a little

neighbor boy had invited him to a birthday party, and that it would be necessary for him to save a clean blouse for the occasion if he were to attend the party. He agreed to do this, but in his excitement and lack of forethought soiled all his blouses before the fateful day arrived. He was quite surprised to find all his available wearing apparel unfit for a public appearance. He attempted to make other adjustments, but none was satisfactory; so he resigned himself to remaining peacefully at home as the natural consequence of his own deeds. Sitting apart in thoughtful mood, this five-year-old was overheard saying to himself: "After all, policemens are good, mothers are good, and God is good." He had himself arrived at this conclusion, and had ventured a generalization.

Not alone is the little child affected by having the connection of cause and effect shown him, but unthinking adults, those children of larger growth, also feel the effects. The parent who is guided by this principle has an excellent opportunity for observation of the growth of the child in thinking. The shortened and discontinuous school period may not offer as rapid growth, yet teachers who attempt guidance based upon this principle would observe development in rational self-determination.

MATURATIONAL CHANGES IN RECTAL TEMPERATURES OF 61 INFANTS FROM 1 TO 36 MONTHS [1]

NANCY BAYLEY AND HERBERT R. STOLZ [2]

The children whose temperatures are here reported were normal, healthy infants who were brought to the Institute of Child Welfare repeatedly for a series of tests and observations. They came at regular intervals starting at the age of one month, every month during the first 15 months, at three-month intervals from 15 to 36 months, and at six-month intervals thereafter. At the visits during the first three years a number of physiological measures, including rectal temperature, were made. After three years of age the temperature readings were discontinued until six years, when mouth temperatures were taken.

The selection of the group and the procedures of observation have been described in some detail elsewhere (3). For the present purposes it may suffice to say that the children come, for the most part, from homes somewhat above average and have parents who are sufficiently interested to bring their children for the repeated visits. The testing procedures include mental and motor tests, physiological measures (blood pressure, breathing rate, pulse rate, and rectal temperature), anthropometric measurements, and photographs, usually presented in the order named. In the older children (after two years) the taking of temperature was usually postponed to the end of the examination period, as the children frequently objected to it. In order to maintain the best possible cooperation for all tests, the policy was followed of leaving to the last any procedures which might not be well received by the child. In the very young infants, on the other hand, when a child was brought in asleep, or nearly so, the physiological measures were sometimes taken first as they served to waken the child, yet were not usually disturbing to him before he was six months old. Otherwise they were taken after the mental and motor tests were completed and before the anthropometric measures were made.

Standard Fahrenheit rectal one-minute clinical thermometers were used and read after 1½ minutes. Mouth temperatures were taken at 72 and 84 months.

At each visit the mother was asked about the child's health and any illnesses which may have occurred since the last visit, and a pediatrician made notations of any conditions of the child's health which might give cause for concern. Starting at two years, a routine physical examination was made, and the pediatrician rated the child for nutrition, development, and physical handicaps to development. Each of these was rated separately, the first two on a seven-point scale, the third (where any handicaps were present) on a five-point scale. With a rating of "1" representing superior nutrition and development, and a "0" rating for no handicaps, a health score made by adding these three ratings together could range from 2 (excellent) to 19 (very poor), with a theoretical average health score of 10. Actually the range of scores was from 2 to 17 with a mean of approximately 8.4.

[1] Many of the computations used in this study were done on a W.P.A. project, No. 65-3-5406.

[2] Institute of Child Welfare, University of California.

RESULTS

Table I gives the mean rectal temperature and the standard deviation for all of the children measured, and for the boys and girls separately. The age curves of means, by sexes (Figure 1), show graphically that the temperatures tend to increase during the first seven months, remain constant from 7 to 24 months, after which they again drop.

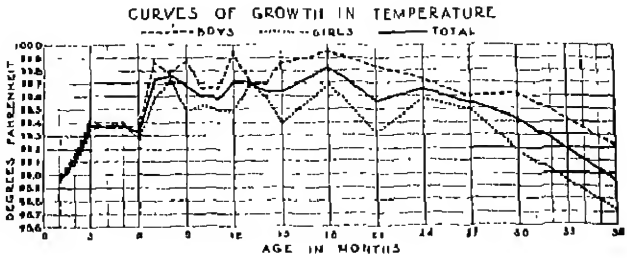

Figure 1. Curves of Mean Temperatures: Months 1 to 36

That this age trend of temperatures is a true characteristic of the group as a whole seems evident from means computed for fewer cases selected for comparisons within the group. When we divide the children by sexes, or when we select the 20 cases born in March to compare with 18 cases born in October and November, the means for all of these smaller samples show the characteristic increase of temperature during the early months, with a subsequent drop after two years of age.

Although sex differences are small and, as indicated by the SD's, overlapping is great, the boys show a consistent tendency to have slightly higher temperatures.

The dispersion of temperatures indicated by the SD's is also brought out in Figure 2, which gives percentage curves of the frequency of the occurrence of

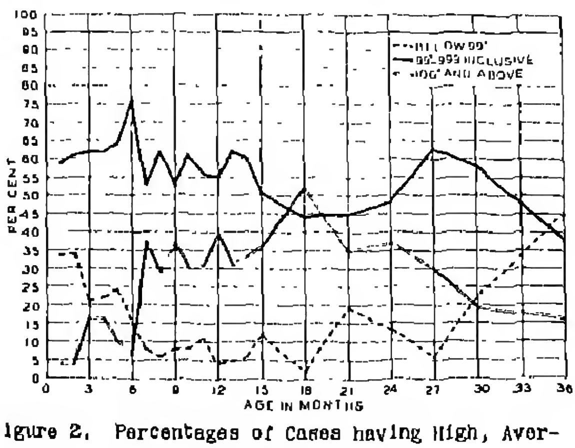

Figure 2. Percentages of Cases having High, Average, and Low Temperatures

Table I

Means and Standard Deviations of Rectal Temperatures

	Month	No. Cases	Mean	S.D.	P.E.
Boys	1	25	98.97	.96	
Girls		25	98.96	.16	
Total		50	98.96	.88	.08
Boys	2	31	99.16	.16	
Girls		25	99.09	.73	
Total		56	99.13	.36	.03
Boys	3	31	99.42	.70	
Girls		30	99.35	.24	
Total		61	99.38	.91	.08
Boys	4	29	99.36	.46	
Girls		28	99.37	.72	
Total		57	99.36	.00	.07
Boys	5	31	99.37	.96	
Girls		26	99.40	.32	
Total		57	99.38	.96	.09
Boys	6	30	99.38	.38	
Girls		27	99.27	.37	
Total		57	99.32	.96	.09
Boys	7	27	99.88	.53	
Girls		25	99.58	.60	
Total		52	99.73	.96	.09
Boys	8	26	99.78	1.00	
Girls		27	99.73	1.00	
Total		53	99.76	.68	.06
Boys	9	27	99.88	.82	
Girls		29	99.48	1.10	
Total		56	99.68	.53	.05
Boys	10	28	99.66	.63	
Girls		27	99.53	.97	
Total		55	99.60	.54	.05
Boys	11	26	99.67	.75	
Girls		24	99.49	.94	
Total		50	99.58	1.04	.10
Boys	12	25	99.95	.61	
Girls		24	99.49	.70	
Total		49	99.72	1.00	.10
Boys	13	23	99.70	.45	
Girls		20	99.70	.94	
Total		43	99.70	.72	.07
Boys	14	19	99.70	.65	
Girls		20	99.59	.56	
Total		39	99.64	.85	.09
Boys	15	23	99.86	.83	
Girls		21	99.40	.96	
Total		44	99.64	.95	.10
Boys	18	23	99.95	.65	
Girls		20	99.70	.61	
Total		43	99.83	.09	.09
Boys	21	22	99.84		
Girls		24	99.32		
Total		46	99.57	.70	.08
Boys	24	19	99.73		
Girls		15	99.58		
Total		34	99.66	1.03	.12
Boys	27	15	99.60		
Girls		15	99.50		
Total		30	99.55	.50	.06

Table 1 (continued)

	Month	No. Cases	Mean	S.D.	P.E.
Boys	30	22	99.62		
Girls		18	99.17		
Total		40	99.42	.69	.07
Boys	36	15	99.22		
Girls		19	98.72		
Total		34	98.95	.66	.08

deviating temperatures as compared with the average - those below 99.0 degrees, those from 99.0 to 99.9 degrees, and those 100 degrees and above. The curve of the central tendency has obviously been influenced by the age differences in extremes of temperature. Readings below 99.0 degrees are rare between 8 and 21 months, while readings of 100 degrees or slightly higher are comparatively frequent during these same ages.

The question arises whether this change in temperatures with age is a true physiological process of maturation or is brought about by the conditions under which the temperatures were taken. As a rule children's temperatures reported in the literature have not been given in such a way that any age changes might be detected. Benedict and Talbot (6) give norms for rectal temperatures for comparable numbers of cases at most months up to one year and at less frequent intervals through twelve years. They report mean values ranging, for boys from 97.1° F at five years (only two cases to 99.5° at 1½ years (8 cases). The mean values for girls range from 98.3° (30 cases) on the first day of life to 99.5° at 11 months (16 cases) and at 1½ years (8 cases). In general they found high average temperatures for boys from ten months to two years and for girls from eleven months to two years. These curves show similar trends to ours except that the temperatures do not rise as high (they were taken during basal metabolism experiments) and the rise occurs three to four months later than in our group. Their results may differ from ours in part because they omitted all temperatures over 100° F.[1]

Our readings were taken between 10 a.m. and 5 p.m., as indicated in Table II, which is based on the total number of readings at eight representative ages (months 1, 3, 9, 12, 18, 24, 30, and 36). Since it was our policy to make the appointments for a child always at the same time of day, individual children's fluctuations in temperature are seldom due to variations in the time of day the readings were taken, and there is no piling up of early or late readings at some ages as compared with others. Table II shows that there is a tendency for higher readings in the afternoon than in the morning. These findings corroborate earlier studies (2, 12, 15, 19), but they do not account for the age changes in the means for this group.

Another extraneous factor which may have affected the temperatures is the emotional disturbance caused by the testing situation. It was necessary to handle the children considerably during the procedures of testing and measuring, and it was thus inevitable that some of them should be upset (4). Also, fearfulness of the strange situation was evident after the first half year. If strong emotions tend to raise the temperature (17), the higher means from months 7 to 24 might be

[1] Jacobsen, Jacobsen & Yoshioka (11) report daily temperatures for an infant chimpanzee, Alpha, from birth to one year. Her temperatures show a tendency to increase from birth to one week and from three to six months of age, with a drop starting during the seventh month and lasting through the ninth.

Table II

Temperatures for Eight Ages Combined, Classed according to Time of Day

Hour	10:00	11:00	12:00	1:00	2:00	3:00	4:00
No. of Cases	71	60	12	17	64	80	65
Mean Boys	99.49	99.42	.....*	.....*	99.83	99.71	99.98
" Girls	98.96	99.13	.....*	.....*	99.65	99.57	99.76
" Total	99.22	99.27	.....*	.....*	99.74	99.64	99.87
S.D.Total	4.44	3.18			2.78	3.02	2.70

*Means were not computed at 12:00 and 1:00 because of the small number of cases measured at these hours.

a result of more emotional disturbance at these ages. Since crying is one objective measure of emotional disturbance in an infant, the amount of time he cried during the test procedures was recorded, and its percentage of the total examination period computed. The median percentages for the group show that the amount of crying diminishes from 1 to 4 months, then increases to 12 months, after which age it diminished rather rapidly, occurring in only a few cases after 24 months of age. The only period where the trends of the mean temperature and crying curves parallel each other is between 6 and 12 months. Coefficients of correlation were computed between temperature and percent of crying at months 1, 3, 6, 9, 12, 18, 24, and 36. The r's are all zero (a representative r being -.09) except at month three where it is .39 ± .08. A comparison of the curves of crying and temperature for individual children showed that the two curves rarely parallel each other. Higher temperatures during examinations when a child cried more than usual do not appear more often than would be expected by chance. In a few cases both high temperature and crying seemed obviously to be related to some disturbance in the child's health at the time of the test. It appears, then, that the age trends obtained for temperatures in this study are not due to the effects of time of day or of emotional disturbance of the child.

To determine whether the variations might be seasonal, depending on the birth month, means were computed separately for the twenty cases born in March, and for eighteen cases born in the fall, mostly in October and November. In both of these samples the means are closely similar to each other and to the means for the total group. The season of the year at which the child was born appears to have no influence on the trend of his temperatures.

STABILITY OF TEMPERATURE IN INDIVIDUAL CHILDREN

There are so many factors which do affect the temperatures of healthy children --diurnal rhythm, sleep, rest and activity, ingestion of food--which could not be held constant in this study, that we should expect considerable variation from month to month in the temperature readings of the same child even though there were no tendency for temperatures to change with age. The fact that coefficients of correlation computed between the temperatures read at two successive months are all around zero may be due either to these diurnal variations or to individual differences in rates of growth changes. In a few cases readings were repeated under more controlled conditions. Figure 3 gives graphically a healthy six-year-old girl's temperatures which were read several times a day for 21 consecutive days. Her morning readings are seen to be, in general, lower than in the afternoon, but for any one hour of the day there is considerable variation. The eight

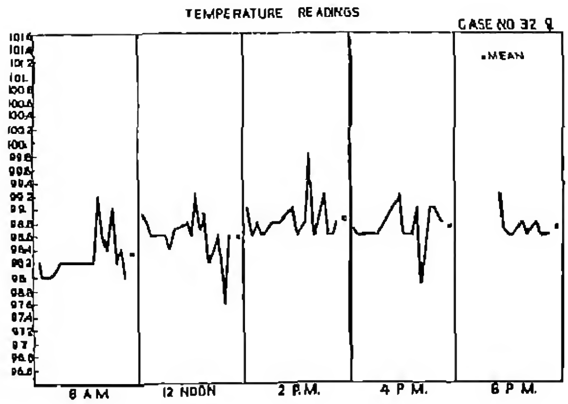

Figure 3. Daily Temperatures of Case 32 at Six Years

a.m. temperatures range from 98.0 to 99.2 degrees; at ten o'clock they range from 97.6 to 99.2 degrees; at two o'clock, from 98.6 to 99.8 degrees; and at 4 o'clock, from 97.9 to 99.2 degrees. It is small wonder, then, that the children's temperatures taken at intervals of a month or longer do not remain constant.

It has seemed probable that variability in temperature is greater in young infants and that as they mature their physiological functions (including temperature regulation) will become more stable. Although the standard deviations from the means show little evidence of such a tendency throughout the first two years, the 27, 30, and 36 month readings are less variable than at most of the earlier ages. And, in addition, the mouth temperatures taken at 72 and 84 months (Table III) have about the same SD's as these later rectal temperatures. Individual children's temperatures may be growing less variable even though the standard deviations for the group remain fairly constant. Children may differ in the ages at which their temperatures are becoming higher or lower, as well as in the amount of fluctuation in temperature which is normal for them.

Table III

Means and Standard Deviations of Mouth Temperatures at Months 72 and 84

	Month 72			Month 84		
	No. Cases	Mean	S.D.	No. Cases	Mean	S.D.
Boys	11	99.2		19	98.8	
Girls	14	99.2		20	98.8	
Total	25	99.2	.56	39	98.8	.59

Since the average curve for the group shows increasing temperatures from 1 through 7 months, and decreasing temperatures after 24 months, we may expect that most children would exhibit the same tendency as they mature from birth through three years. An inspection of the individual curves shows this to be true, in general, with individual variations in the age at which the higher temperatures occur. However, the fluctuations in temperature resultant from the immediate conditions of environment, diurnal rhythm, etc. make the individual curves very irregular. It may be permissible to assume that these irregularities are variations

on a central tendency which is more fundamental, and related to the child's age and inherent physical make-up. Such an assumption can be made only with strong reservations because of the infrequent intervals at which the temperatures were read. However, the following discussion is based on this assumption.

If we wish to study variability in individuals, a child's deviation from his own central tendency should take his age trends into account. In order to do this we plotted curves of the individual children's temperatures with age and drew (by eye) a smoothed line through each curve. Assuming this smoothed line to be indicative of the central tendency of temperature for that child, the deviation of the actual reading from this line for each age was read from the chart and recorded as his "deviation score." The means of these deviation scores were computed for months 2 to 15 inclusive and for months 18 to 36 inclusive. As is shown in Table IV the total group averages of these deviations are no larger for the first 15 months than for the 18 to 36 month period. The average deviations of these deviations, however, are smaller for the later age group, indicating a slightly greater stability with increasing age.

Table IV

Means and Average Deviations of Deviation Scores, Younger Ages Compared with Older Ages*

	Months 2 to 15		Months 18 to 36	
	Mean	A. D.	Mean	A. D.
Boys	.32	.17	.31	.12
Girls	.37	.19	.37	.14
Total	.34	.18	.34	.13

*The means for the separate ages are not given, but instead, the mean of the mean deviation scores for months 2 to 15 inclusive, and another mean for months 18 to 36, inclusive.

Some children appear to be far more labile than others, and there are wide differences in the extent to which a child's temperature fluctuates. This is shown in Figures 4 and 5 where the highest and the lowest readings taken for each child are indicated. Figures 6 and 7 illustrate this in another way with curves of individual children, two with small variation in temperatures and two with wide variation.

The age curve of the mean temperatures, up to a certain point, follows the curve of body build (Weight divided by Length, squared) for these same children (5). The mean W/L^2 index rises from 1.41 at month one to 1.83 at month eleven, then drops until at month thirty-six it is 1.63. At seven months, when the temperatures have reached an approximate plateau around 99.7°, the W/L^2 index has gone up to 1.76; by twenty-four months the index has returned to 1.71 and after this the temperatures drop as the children become more slender. At the ages when children are most chubby their temperatures tend to be higher. During the period of increasing chubbiness (W/L^2) some children become much more chubby than others. Possibly a child's temperature tends to be high or low according to his body build. That is, plump, relatively heavy children may as a rule have higher temperatures than thin, relatively light children. When we try to compare these two variables, we are confronted, in both instances, with data which fluctuate widely. Temperature varies with time of day and is more affected by immediate conditions; while the W/L^2 index varies over somewhat longer intervals with variations in rates of growth.

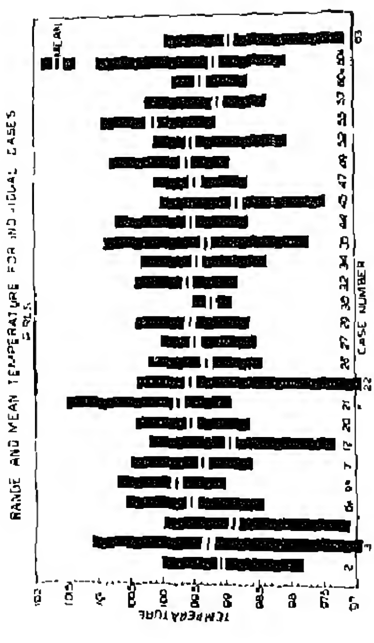

Figure 4. Range and Mean Temperature for Individual Cases: Girls

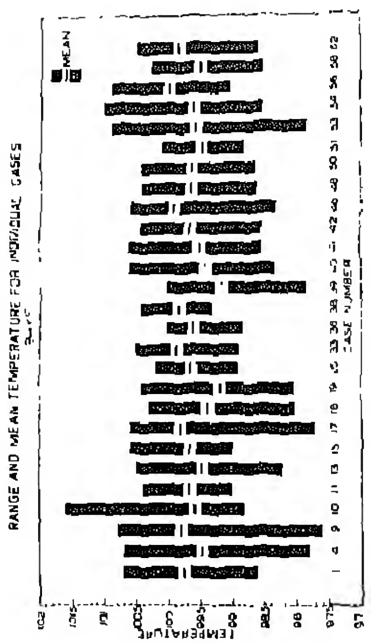

Figure 5. Range and Mean Temperature for Individual Cases: Boys

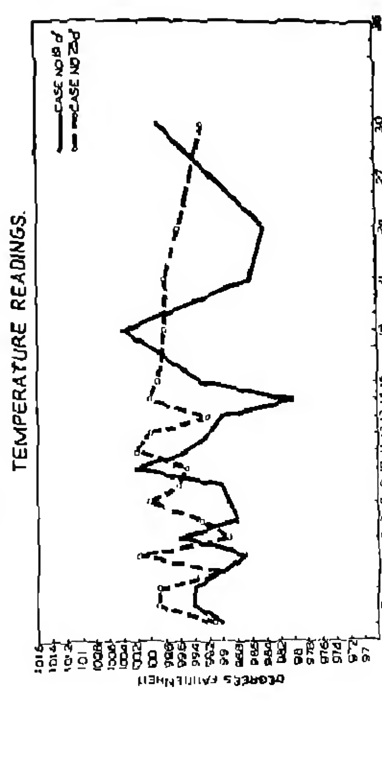

Figure 6. Individual Curves of Temperatures

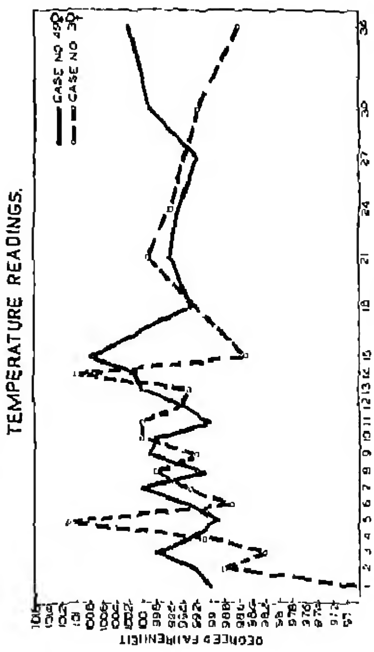

Figure 7. Individual Curves of Temperatures

From a comparison of individual curves of the W/L^2 index and temperature readings, it was evident that no correlation would be found for any one age between a child's temperature (single reading) and his W/L^2 index. However, when a mean temperature (composed of all temperatures taken at all ages when the child was well) was computed for each child, this average measure correlated with the W/L^2 index at 12 months $+.35 \pm .087$, and at 36 months $+.42 \pm .080$. Although these r's are not high, they are greater than would be expected by chance. They appear to indicate that body build is one factor which is related to the child's temperature.

THE RELATION OF TEMPERATURES TO HEALTH AND ILLNESSES

Donald (10), in a study of twenty institution children who were carefully selected as in excellent physical condition, found a tendency toward constant high temperatures in 30% of the cases, and a few children whose temperatures were characteristically "subnormal." Abt (1) reports similar findings from his practice.

As previously stated the temperature readings used in this study were made on presumably well children. However, these children present some differences in their health records; and the extreme high or low temperatures found at times when the children were apparently well may be related to poor health or a tendency toward frequent illnesses.

In order to study the relationship to illnesses, all illnesses were rated for their severity, on the basis of the mothers' descriptions and the nature of the disease, on a five-point rating scale. Such things as a slight cold were given a rating of "1"; severe illnesses, a rating of "5". In this way we were able to compute an illness score (incidence weighted for severity) for each child for any age-interval which it was desired to study. Figure 8 gives the incidence, in three-month intervals, of the infectious diseases occurring in these children during the first three years. Colds and infections other than epidemic diseases were found to occur at all ages. While epidemic diseases did not put in an appearance during the first six months, they were present in small numbers throughout the rest of the age-range. When all illnesses were rated for severity, the total weighted incidence for each three-month interval was found to be as represented in Figure 9. Comparing this figure with the curve of mean temperatures, we find some correspondence between the ages of more illness and high temperatures, though there are exceptions at 18 and 36 months. When each child's average temperature for all readings through 36 months is compared with his weighted illness score for the total 36-month period, the correlation is $.28 \pm .087$. This may indicate a slight tendency for high temperatures to be found in the children with more frequent illnesses, as well as at the ages when illnesses were more

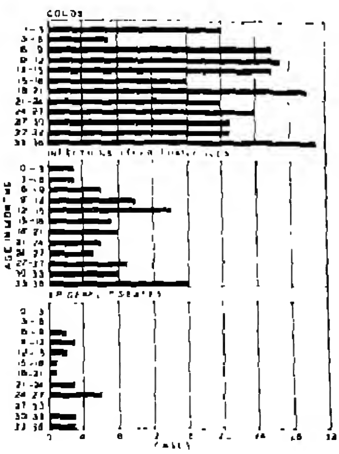

Figure 8. Incidence of Infectious Diseases.

frequent. This relation, however, is not statistically significant.

When we correlate the average temperatures with the health scores based on the physician's ratings, the r with the score at 21 months is +.21 and at 36 months, -.22. In these children present health bears no relation to an average of past temperatures.

We may study this health-temperature relationship further by considering the children whose temperatures were repeatedly 100 degrees or above and those with temperatures repeatedly below 99.0 degrees. To make this comparison we carefully excluded all readings made at a time when a child showed any other evidence of infection, digestive upset or other physical ailment which might possibly affect the temperature. With the exception of two girls all of the children had at least one reading of 100 degrees or above and many had three, four, or five such readings. There were five boys and one girl whose temperatures, under these conditions, exceeded 99.9 degrees for 50% or more of the measures. They are given in Table V.

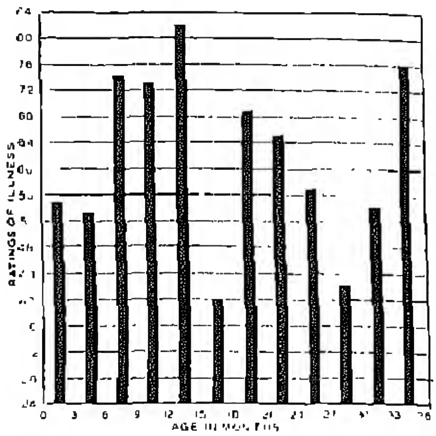

Figure 9. Weighted Incidence of Illnesses by Three-Month Intervals.

Table V

Cases with Frequent High Temperatures

Case	Temperatures 100° or above	Per Cent	Usual Time of Day
9	7 of 12	58	9 to 10 a.m.
17	7 of 13	54	2 to 3 p.m.
33	12 of 16	75	3 to 4 p.m.
46	12 of 20	60	3 to 4 p.m.
56	10 of 17	59	10 to 11 a.m.
55	14 of 18	78	3 to 4 p.m.

Four of these children were usually tested in the afternoon, when temperatures tend to be higher, but the proportion of morning to afternoon readings for these six children is the same as for the entire sample. Cases 9, 17, 46, and at some ages 56 have a chubby body build. Three of the children (cases 9, 55, and 56) had high illness scores, while a fourth (case 33) had a rather high illness record. Of these three factors which have been shown to be more or less related to high temperatures, at least one, and usually two, are found for each of these children.

Cases 9 and 56 attended the nursery school, and we have for them a series of daily temperatures taken at the same time of day when they were about three years of age.[1] Case 9, for ten daily readings at 9:00 a.m., had a mean temperature of 99.6° with a range from 98.9° to 100.1°. For another series of ten days his nine o'clock readings ranged from 99.0° to 99.8° with a mean of 99.5°; however, one

[1]These figures were kindly supplied by Mrs. Gladys N. Ludwig of the Institute Nursery School.

hour later on these same ten days his range was from 100° to 101.1° with a mean of 100.6°. His temperatures appear to be very easily raised by exercise and active play.

Case 56, at 9:00 a.m., had ten temperatures ranging from 99.7° to 100.5° with a mean of 99.9°--definitely above the mean for the entire nursery school group of 99.4° at 9:00 a.m.

Although most of the children had some readings below 99.0°, only one child had such low ratings as often as 50% of the time, and there seems to be no significant relation between illnesses and frequent low temperatures.

This approach shows again that the children in this group who were prone to high temperatures when they were well were also, as a rule, more subject to illnesses. But the exceptions indicate that considerable variation in temperatures may normally be expected in healthy children. (Several children with high illness scores do not fall into the high-temperature group.)

SUMMARY

In summary, an analysis of the rectal temperatures taken on this group of 60 children, as they grew from birth to three years, has brought out several points.

1. Temperatures in infants tend to increase during the first seven months and to drop again between 24 and 36 months of age. The mean rectal temperatures for the total group vary for the different ages from 98.96° at month one to 99.76° at month eight and 99.83° at month eighteen, and drop back to 98.95° at month thirty-six.

2. Mouth temperatures for 25 children at six years averaged 99.2°, and for 39 children at seven years averaged 98.0°.

3. The boys' temperatures are, on the average, slightly higher than the girls' although the overlapping in the sex distribution is very great.

4. The temperatures taken varied widely when we take into account what is usually considered "normal". This is true for the group at any one age, and for any one child at various ages. The variability appears to be somewhat less after the first two years.

5. Aside from changes due to maturation and diurnal rhythms, these children's temperatures appear to be related to a number of factors. Among these factors are body build and possibly susceptibility to illnesses.

6. There is some evidence that healthy children may have consistent tendencies toward high temperatures or toward low temperatures which are normal for them.

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TWIN RESEMBLANCES IN MECHANICAL ABILITY, WITH REFERENCE TO THE EFFECTS OF PRACTICE ON PERFORMANCE [1]

DAVID BRODY [2]

INTRODUCTION

Although extensive studies on twin resemblances have served as an important approach to the problem of mental inheritance, no twin data relating to the inheritance of mechanical ability have been reported in the literature. The present study aims at an approach to this problem through an analysis of the degree of twin resemblances in performance on the Minnesota Spatial Relations test which is a form board designed to measure mechanical ability.

Of importance in an evaluation of the twin technique is the assumption that the environment of fraternal twins of like sex is as uniform as that of identical twins. Such an assumption requires close examination, for unless we can assume a constancy of environment for both fraternal and identical twins, any inferences as to genetic contributions must be modified accordingly. For one thing, the very factor of genetic dissimilarity will tend to operate so as to produce a greater variability of environment for fraternal twins than for identical pairs. Stocks (11) illustrates this point very well when he states that, ".....many dizygotic twins are very different in general body build, healthiness, taste, and temperament, so that they naturally tend to subject themselves or be subjected to differences in nurture to a greater degree than monozygotic twins who have usually the same needs, tastes, and inclinations, and are rarely seen apart during childhood."[3] Likewise Jones and Wilson (5) in a study of reputation differences between like sex twins find that individual pairs of monovular twins are generally considered to be more alike than diovular pairs and conclude ".....that this effect is to contribute an environmental differentiating factor which is greater for fraternal than for identical twins."[4] It becomes important, then, to recognize the role of inheritance in affecting the degree of similarity of environment between twin pairs.

One may, however, seriously question whether the greater similarity of environment of identical twins is sufficient in itself to account for the marked differences in the degree of resemblance between the two types of twins. The point to be emphasized, rather, is the need of caution in drawing inferences from comparative studies of identical and fraternal twins.

Diagnosis of Twinning

The writer in his work employed a scheme which combined the criteria taken from the separate scales constructed by Dahlberg (1), Siemens (10), and Newman (8). These criteria are:

[1] The writer wishes to express his appreciation to Dr. Florence L. Goodenough and Dr. John E. Anderson for helpful suggestions and criticisms.

[2] From Institute of Child Welfare, University of Minnesota.

[3] Stocks, P. Annals of Eugenics. April, 1930, page 101.

[4] Jones, H. E. and Wilson, P. T. J. Exper. Educ., 1932-33, 1, p. 41.

1. The appearance of the twins must give an impression of very great resemblance or identity.
2. That during childhood, neighbors, school fellows, etc. have had difficulties in distinguishing them and have sometimes confused them.
3. That the configuration of the ears does not show great dissimilarity.
4. That the finger prints show a high degree of similarity.
5. That the anthropological measurements do not show any marked difference.

Measurement of Mechanical Ability

The test used was the Minnesota Spatial Relations Test which was selected from the battery devised in the Minnesota Mechanical Ability Studies (9). An examination of the data relating to the separate tests in this battery indicates that of the tests listed the Minnesota Assembly and the Minnesota Spatial Relations tests most adequately meet the criteria of validity, reliability, and uniqueness. The significance of uniqueness is best indicated by the following quotation from the Minnesota study:

> ".....From the point of view of the theory of unique traits the task of measuring mechanical ability must meet two theoretical demands. The first is that the tests be constructed to correspond with actual achievements in work generally regarded as requiring mechanical ability, identifying them as tests of mechanical ability only on the basis of correlations with outside criteria. The second demand is that the measures be of mechanical ability and not of some other ability which may be closely related to it and which for that reason might possibly be confused with it."[1]

A study of sex differences points to the Spatial Relations test as the more satisfactory of the two for a research study of this kind. Strikingly greater sex differences on the Assembly test strongly suggest the effect of environmental factors upon performance in this test. The Minnesota study (9) indicates that the superiority of the males must be attributed to social pressures which allow them greater opportunity to engage in the specific type of mechanical work measured by the assembly test. The spatial relations test which is just as valid a measure of mechanical ability (as determined by the shop-work criterion) fails to indicate a distinct male superiority, and hence, suggests that opportunity for specific practice is considerably less for this type of performance.

The Minnesota Spatial Relations test consists of four form boards containing 58 cut-outs each. The test is so constructed that Boards A and B contain identical cut-outs differing from one another only to the extent that the recesses of each board are arranged in a different pattern. Boards C and D are constructed in a similar manner, but the cut-outs used are different than those for Boards A and B. The entire test, then, can be subdivided into two comparable tests: (1) Boards A and B; (2) Boards C and D.

The reliability of the four boards when administered to 100 Junior High School boys as reported in the Minnesota Study was .84. When checked against a shop-work

[1] Paterson, D. G. et al. Minnesota Mechanical Ability Studies, page 22.

criterion, the test yielded a validity coefficient of .53.

PROCEDURE

In a survey of the Minneapolis public schools, sixty-two pairs of twin boys of grade school age were secured for study. Owing to the difficulty of securing twin subjects, it was found necessary to accept all available twins in the grade school population. The distribution of these pairs according to chronological age is indicated in Table I.

Table I

Distribution of Twin Pairs According to Chronological Age

C.A.*	Number of Pairs Identical	Fraternal	Total
8	5	7	12
9	5	6	11
10	1	5	6
11	6	6	12
12	8	6	14
13	3	3	6
14	1	0	1
TOTAL	29	33	62
AV. C. A.	10.78	10.13	10.44
S. D.	1.78	1.62	1.73

*Chronological age is taken from the nearest half year. Thus, all children varying in age from 7 years, 6 mos, to 8 years, 6 months, are classified under the 8 year category.

The testing program was carried out over a period of eight months, from January to September, 1935. During the winter and spring months the subjects were tested at the schools. In the summer, they were tested at their homes if conditions permitted; otherwise, they were brought to the Child Welfare Institute of the University of Minnesota.

The general procedure as outlined in the report of the Minnesota mechanical ability studies (9) was followed in detail in the administration of the test.

In the cases discussed here, a high degree of motivation was maintained throughout the testing period by encouraging each subject to improve his previous score. In addition, intra-pair competition was stressed so that each twin was constantly motivated by the desire to excel his brother. Rapport was established with very little difficulty, since the boys regarded the test as a contest or a game.

In order to determine the effect of practice on twin resemblances each subject was given six successive trials on Boards A and B in alternation. Those trials constituted the practice series. Immediately following the practice series each subject was given the final test on Boards C and D. Each subject proceeded with the subsequent trial as soon as he indicated that he was sufficiently rested. In general, the intervals between tests varied from one to five minutes.

Wherever possible the testing of one member of a pair was immediately followed by the testing of the other member. In all cases both members of a pair were tested during the same day.

Scores are expressed in terms of the total number of seconds taken to place the 58 blocks in each board.

In order to determine whether any relationship exists between the form board performance and intelligence in children younger than those on whom the Minnesota test was first standardized, the Kuhlman-Anderson group tests were administered

to all twin pairs. The intelligence tests were administered within one to two days after the subjects had been given the Spatial Relations test.

RESULTS

Inter-Correlation of Test Scores

The reliabilities of Boards A and B and of Boards C and D as determined by correlations between tests are presented together with the mean score and the standard deviation for each board in Table II. In computing the reliability of Boards A and B only the first trial on each was considered. The greater variability of scores on Boards A and B makes the comparatively larger reliability coefficient of Boards C and D still more significant.

Table II

Reliability of the Test

	Mean	S.D.	Reliability	Reliability (Sp.-Br.)
Board A	494.7	163.1		
Board B	391.3	129.2	.744	.853
Board C	397.9	137.1		
Board D	370.8	121.5	.764	.805

The increased reliability may be due to practice effects. Darley (2), who administered the test to adult subjects, reports greater reliability for Boards B, C, and D when Board A is used as a practice trial.

In a study of practice effects it becomes important to determine whether the same function is being tested from one practice trial to another. In the test used in this study it is possible that the later trials measured a memory factor unrelated to mechanical ability.

Evidence that the practice trials measured mechanical ability may be found in an inspection of the correlations between the practice trials and the combined scores in the final series. These data, presented in Table III, indicate a consistently high relationship between practice trial performance and the combined scores on C and D.

Table III

Correlations between the Scores on the Separate Practice Trials and the Combined Score on Boards C and D

Practice Trial	Correlation *
1A	.709
2B	.843
3A	.817
4B	.835
5A	.850
6B	.871

*The P.E. r for $r = 0$ is $\pm .06$

Since the arrangement and the forms of the cut-outs in Boards C and D are different from those in Boards A and B, it cannot be assumed that the high relationship is due to practice in memory-motor functions unrelated to mechanical ability. Rather, the evidence suggests that a similar type of performance is being measured from one practice trial to the other.

Effects of Practice

The data presented in Table IV show the relationship of age and practice to performance. Because of the small number of cases at each age level the scores

Table IV

Mean Scores Made by Subjects of Different Age Levels

	8 yr. (N=24)	9 yr. (N=22)	10 yr. (N=12)	11 yr. (N=24)	12 yr. (N=28)	13 yr.* (N=14)
1-A	593	569	552	443	416	314
2-B	494	467	429	346	317	287
3-A	377	391	320	296	256	246
4-B	361	359	352	263	260	225
5-A	343	334	297	262	241	205
6-B	328	338	285	252	245	210
C	485	500	437	357	313	292
D	445	436	402	346	311	278

* In this instance the two members of the 14 yr. old pair have been classified under the 13 yr. category.

of the various age groups were combined into two categories, namely, an 8 to 10 yr. group and an 11 to 14 yr. group. The curves for these two groups and that for the total number of subjects are plotted in Figure 1. In all three cases the curves tend to approximate the general form of a negatively accelerated curve.

A study of the curves relating to performance on Board C indicates a transfer effect carried over from performance on the practice series. Thus, for all subjects there was an average reduction of 86 seconds in time scores between the first practice trial and the performance on Form C. This improvement of score was also characteristic for each of the age groups, and is indicated by the magnitude of the critical ratios presented in Table V.

Table V

Differences in Mean Scores on Trials 1A and Form C

Age Level	Av.-1A	Av.-Form C	Diff.	σ diff.	D/σ diff.
8	593	405	188	6.6	16.4
9	569	500	69	8.1	8.5
10	552	437	115	9.6	11.9
11	443	357	86	6.8	12.6
12	416	313	103	6.3	16.3
13	314	292	22	5.6	3.9
8-10	575	481	94	6.1	15.4
11-13	404	325	79	5.3	15.0
ALL	484	398	86	5.2	16.5

There was a general tendency for variability of scores to decrease with practice. This tendency is illustrated in Table VI which indicates that variability is at a minimum on the fifth trial and increases slightly on the sixth.

Table VI

Mean Scores and Standard Deviations

	* 8 - 10 (N=58) Mean	S.D.	11 - 14 (N=66) Mean	S.D.	All (N=124) Mean	S.D.
1A	575	145	404	133	484	163
2B	470	128	321	80	391	129
3A	370	88	260	43	316	86
4B	353	76	253	51	300	81
5A	330	72	241	44	283	74
6B	323	80	240	49	279	77
C	481	141	325	80	398	137
D	432	121	316	92	370	121

* Age taken from the nearest half year.

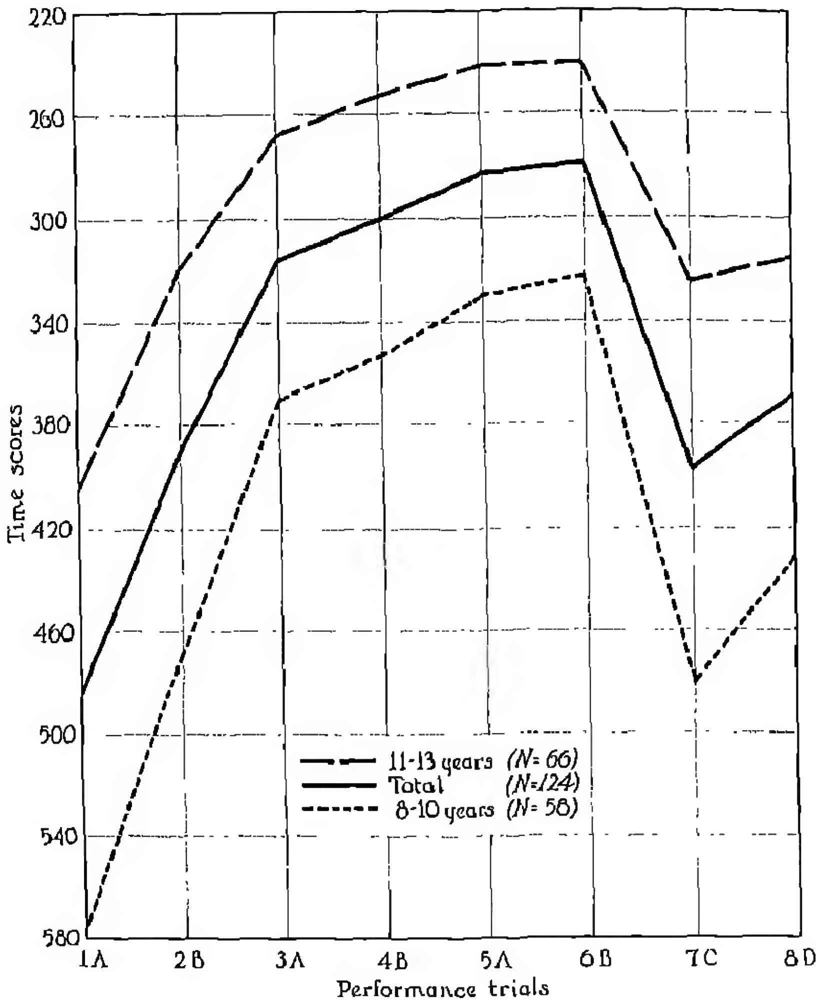

Figure 1.- Mean Performance Scores by Age Groups.

However, any comparison of the mean scores and standard deviations of the separate age groups and of the practice trials must be regarded very carefully, since the scores as indicated by the time units cannot be assumed to be equal at different points on the practice curve. Thus, a reduction of time from 240 to 230 seconds probably represents a greater improvement than a reduction of time from 530 to 520 seconds. That is, the score units which are "physically" comparable cannot be regarded as "psychologically" comparable.

Although the members of the younger group are more variable than the older subjects, the coefficients of variability in Table VII suggest that this greater variability may be a product of the unequal units of the learning curve.

Analysis of Intra-pair Differences

A comparison of the means of the absolute differences in scores between the

Table VII

Coefficients of Variability

	8 - 10	11 - 14
1-A	25.2	32.9
2-B	27.2	24.5
3-A	23.0	17.5
4-B	21.5	20.2
5-A	21.8	18.2
6-B	24.8	20.4
C	29.3	24.6
D	28.0	29.1

twin pairs as presented in Table VIII shows a markedly closer resemblance for the identical twins. This greater similarity of identical pairs becomes all the more evident when an analysis is made of the means of the intra-pair differences on the combined scores of Boards C and D. In this case a D/σ diff. value of 12.6 was obtained. The inconsistent trend in the size of the critical ratio with practice suggests that practice as such has no effect on the degree of differences in resemblance between fraternal and identical twins.

Table VIII

Means and Standard Deviations of Absolute Differences between Pairs Together with Critical Ratios

	Fraternal (N=33)				Identical (N=29)				Diff. Between Means	$\sigma_{diff.}$	D/σ diff.
	Mean	σ mean	S.D.	σ s.d.	Mean	σ mean	S.D.	σ s.d.			
1-A	108.3	13.1	75.2	9.3	86.4	15.9	85.4	2.9	21.9	5.18	4.1
2-B	97.7	15.3	87.7	10.8	60.5	9.8	53.0	4.9	37.2	5.01	7.4
3-A	57.1	8.0	46.1	5.7	41.6	9.8	52.9	2.0	15.5	4.22	3.7
4-B	57.1	6.9	39.4	4.8	39.1	6.2	33.2	2.5	18.0	3.62	5.0
5-A	54.1	5.2	29.6	3.6	24.3	3.4	18.6	2.9	29.8	2.93	10.2
6-B	49.5	6.1	34.8	4.3	30.5	6.0	32.3	2.5	19.0	3.48	5.4
C	90.4	13.2	75.6	9.3	73.3	11.8	63.0	2.2	17.1	5.0	3.4
D	98.0	13.4	76.9	9.5	57.4	15.2	81.0	5.3	40.6	5.35	7.6
C & D	173.6	21.5	123.6	15.2	89.3	23.0	125.3	11.1	84.3	6.69	12.6

Analysis of Resemblance Coefficients

Unfortunately, the wide age range of the subjects tested and the small number of cases at each age level make the interpretation of resemblance coefficients somewhat hazardous. This is especially so in light of the fact that an analysis of the data indicates a curvilinear relationship of test performance to chronological age. For this reason the product-moment partial correlations in Table IX are presented only as a possible suggestion of what the differences in resemblance between fraternal and identical twins might be if age were held constant experimentally.

Despite the limits of interpretation, however, it is interesting to note that the partial correlations tend very definitely to substantiate the findings indicated in an analysis of intra-pair differences. The data at hand, then, can leave very little doubt as to the fact that identical twins resemble one another much more closely in performance on the Spatial Relations Test than do fraternal pairs. A final evaluation of this point, however, must rest on a study of an adequate number of twin pairs of the same age.

Of interest to this study is McNemar's (6) report of the effects of practice on twin resemblances in motor skills. His analysis based on homogeneous groups

Table IX

Resemblance Coefficients in Mechanical Ability*

	Fraternal			Identical		
	Total Correlation	Relationship of Test Performance to Age	Partial Correlation (age held constant)	Total Correlation	Relationship of Test Performance to Age	Partial Correlation (age held constant)
1-A	.626	.578	.438	.748	.537	.646
2-B	.538	.659	.184	.760	.545	.659
3-A	.595	.775	-.015	.708	.498	.613
4-B	.678	.686	.393	.747	.535	.645
5-A	.648	.703	.303	.889	.624	.819
6-B	.674	.676	.399	.823	.462	.775
C	.622	.636	.366	.733	.502	.643
D	.445	.612	.113	.690	.372	.640
C & D	.642	.670	.351	.803	.452	.752

*Resemblance coefficients calculated from double entry scattergrams.

(i.e. with respect to range of scores) showed that practice on the pursuit rotor and spool packing tests increased the resemblance of fraternal twins but that it had no effect on the degree of resemblance of identical twins. On the card sorting test both the fraternal and identical twin pairs showed a slight decrease in resemblance.

Intelligence Test Results

Since it is doubtful that the I.Q.'s on group tests have the same significance at the different age levels, the results on the Kuhlman-Anderson tests must be interpreted with caution.

The mean I.Q. for the total number of twin subjects was 98.35, for the identical group 99.31, and for the fraternal group 97.5. It is interesting to note that the results conform to the findings of Day (3), who in summarizing the literature on the differences in mean I.Q. between fraternal and identical twins, reports that in each of the research studies reported, the identical twins show a consistent superiority to the fraternal twins. The reason for this is not apparent.

The resemblance coefficients in intelligence presented in Table X are lower than those usually reported in the literature. As two typical studies the results of Wingfield (12) and of Merriam (7) are cited. A comparison of the standard deviations in Table X, however, make it evident that the smaller values of r in the present study may be explained by the comparative difference in variability.

Table X

Resemblance Coefficients and Standard Deviations of I.Q.'s on Merriman's, Wingfield's and the Present Studies

	Merriman		Wingfield		Present Study	
	r	S.D.	r	S.D.	r	S.D.
Fraternal	-	-	.70	13.5	.550	9.17
Identical	-	-	.90	14.3	.844	9.86
Combined	.782	15.1	.75	12.65	.705	9.54

Table XI shows that the relationship between performance on the Spatial Relations Test and intelligence (as measured by the Kuhlman-Anderson test) ranges from .031 to .218 on the separate practice trials. This low degree of relationship between mechanical ability and intelligence is in harmony with the test results on 7th and 8th grade children as reported in the Minnesota study (9).

Table XI

Correlations between Time Scores on the Spatial Relations Test and I.Q.'s on the Kuhlman-Anderson Test

Trial	Correlation*
1-A	.216
2-B	.114
3-A	.091
4-B	.162
5-A	.140
6-B	.083
C	.172
D	.134
C & D	.173

*P.E. r for r = o is ±.06.

SUMMARY AND CONCLUSIONS

The purpose of the present study was to determine the degree of twin resemblances in performance on the Minnesota Spatial Relations Test, which is a form board designed to measure mechanical ability. The test was administered to 62 pairs of twin boys of grade school age, 29 of which were diagnosed as identical and 33 as fraternal. The mean I.Q. of the fraternal twins was 97.5 and of the identical twins 99.3. Six successive trials on Boards A and B were given as a practice series. This was followed by the final test on Boards C and D. The results follow:

1. The reliability coefficients for the separate Boards are .853 for A and B and .895 for C and D.
2. The correlations between the practice trials and the combined score on C and D suggest that the same function is being measured on all practice trials.
3. A study of practice effects revealed that (a) variability of scores decreased markedly with practice, (b) the practice curve was negatively accelerated, and (c) there was a transfer effect from the practice to the final series.
4. An analysis based on intra-pair differences and resemblance coefficients showed a markedly closer resemblance between identical twins than between fraternal twins.
5. There is apparently no relationship between twin similarity and the number of practice trials.
6. There is no relationship between performance on the Minnesota Spatial Relations Test and intelligence.

It may be concluded from an analysis of intra-pair differences and from the trends indicated by the resemblance coefficients that identical twins resemble one another much more closely in performance on the Minnesota Spatial Relations Test than do fraternal pairs. The most plausible explanation of this difference in the degree of resemblance between the two groups of twins is that for fraternal pairs there is a greater differentiation of hereditary capacities. It hardly seems likely that the greater similarity of environment between the identical twins would account for the obtained results in that all conditions of testing were held constant for both sets of twins.

The results on twin resemblances in themselves do not allow for a complete evaluation of the environmental factor as it affects mechanical ability. They merely indicate that underlying the ability to perform on the Minnesota Spatial

Relations Test is an important hereditary factor which cannot be neglected. Hogben's (4) point of view is particularly relevant to this aspect of the problem. He states: "The study of twin resemblance shows that the inborn capacities of individual men and women are different. Of itself it does not assist us to form any judgment concerning the extent to which such inborn differences are related to existing inequalities of social privilege...."

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THE MENTAL DEVELOPMENT OF CHILDREN OF THE SAME IQ IN DIFFERING INSTITUTIONAL ENVIRONMENTS

ORLO L. CRISSEY[1]

THE PROBLEM

The concept of intelligence as fixed and unmodifiable, or only modifiable within very narrow limits, is yielding to a viewpoint which conceives of intelligence in more functional terms. No longer can it be said that an early intelligence test rigidly classifies a child for life in terms of mental potentialities. Rather, changes in functional mental performance are seen to be related to environmental differences. Recent studies, especially of children at the younger ages, have shown that these changes may be large in extent and appear to follow certain trends in relation to general environmental influences.

Studies of preschool and school age children by Wellman (4) and Skeels (3) have shown that groups of individuals at the mental levels below the central tendency of a population appear to gain on retests, while those at the upper levels tend to gain less or to lose in IQ. The factors responsible for these phenomena are difficult to understand. Do gains (or smaller losses) at the lower IQ levels of a population mean that the average sets the "stimulation level" for the group, tending thus to encourage those at the lower levels to greater attainment, while those in the upper categories are not challenged to attain their relative potentialities to a similar degree? Perhaps Sherman and Key (2) are right when they explain the general decreases in intelligence quotients of children in an isolated Virginia community as due to living in an environment which does not demand greater development. Do children develop only as the environment demands development? Or, applied in another way, does an environment "geared" to the average child of a population tend to stimulate more highly those individuals below the central tendency of the group, by demanding more of them, and fail to stimulate similarly those above the average? Do environments of differing mental levels show differences in these relationships?

If the mental level of an environment is an important factor in a child's mental development, then the rate of mental development of a child in an institution designed for normal and dull-normal children should vary from that of a child of similar mental ability in an institution designed for the feeble-minded. It is the aim of this study to investigate the mental development of children of the same mental level in relation to residence in institutional environments of differing mental level.

SUBJECTS

The subjects for this investigation consist of children resident in four Iowa institutions: the Iowa Soldiers' Orphans' Home at Davenport, the State Juvenile Home at Toledo, the Institution for the Feeble-Minded at Glenwood, and the Hospital for Epileptics and School for Feeble-Minded at Woodward. The cases used were

[1] From Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

CHILD DEVELOPMENT, Vol. 8, No. 3 (September, 1937)

selected from a large number of children who had been given individual tests, and who were resident in these institutions between an initial test and one or more retests. Subjects who were over sixteen years of age at the time of the initial test or retest were eliminated so as to make all intelligence quotients computed on the basis of actual life age. No colored children, epileptics, physical anomalies, or cases at the idiot or low imbecile levels were included.

For convenience, the following key will be used in referring to these institutions:

Institution A:	The Iowa Soldiers' Orphans' Home at Davenport
Institution B:	The State Juvenile Home at Toledo
Institution X:	The Institution for Feeble-Minded at Glenwood
Institution Y:	Hospital for Epileptics and School for Feeble-Minded at Woodward

TESTS AND PROCEDURE

The Stanford and Kuhlmann revisions of the Binet scale were used for all individual tests. The use of the Kuhlmann, however, was limited to only a few younger children for whom a basal mental age of three years could not be obtained on the Stanford. All tests were administered by well-trained examiners as a part of the co-operative program between the Iowa Child Welfare Research Station and the Iowa Board of Control of State Institutions. These tests have been given at varying intervals during the last eight years.

The approach used in this study is the method of matched groups. In order to obtain as fine control as possible, three criteria were decided upon as the bases for selection in pairing:

1. Individuals must be within 3 points in IQ on initial test.
2. At the time of the first test, chronological age must not vary more than six months.
3. The length of intervals between the respective initial tests and retests must be within six months.

Various environmental comparisons were set up by pairing individuals in homes for dependents with children in institutions for the feeble-minded on these bases. Residents in the homes for dependents were paired not only with nontransfers in the schools for the feeble-minded, but also with children who had been previously transferred from the homes for dependents. In most cases only one individual was paired with another, but in some instances where the criteria were met, one individual might enter into two or more pairings. These cases were the exception rather than the rule. The following environmental groupings are compared in relation to mental development.

1. Residents at homes for dependent children, Institutions A and B, with nontransfers in schools for the feeble-minded, Institutions X and Y
2. Residents at Institutions A and B with transfers from these institutions to Institution X
3. Residents at Institution A with transfers from Institutions

A and B to Institution Y
4. Residents at Institution B with transfers from A and B to Y
5. Total pairings of residents at Institutions A and B with transfers and nontransfers at Institutions X and Y by chronological age groupings (under six, seven to twelve, thirteen and over)
6. Total pairings of residents at Institutions A and B with transfers and nontransfers at Institutions X and Y

RESULTS AND CONCLUSIONS

Analyses of these comparisons are presented below in two tabulations. In the first, children of the same IQ resident in environments of differing mental level are studied on the bases of the various environmental groupings. In the second tabulation these pairings have been classified according to age groupings. The results of these analyses are as follows:

Matched Groups	Children	Net Changes in IQ			IQ	
		Mean	S.D.	$S.E._M$	Mean	Range
Residents at Institutions A and B	48	.5	6.0	.9	68.6	51 to 98
Residents at Institutions X and Y	48	-5.5	7.1	1.0	68.9	52 to 99
Residents at Institutions A and B	30	3.6	7.4	1.4	69.0	60 to 74
Transfers to Institution X	30	-4.7	7.3	1.3	68.9	61 to 73
Residents at Institution A	49	2.6	7.8	1.1	68.4	50 to 75
Transfers to Institution Y	49	-7.9	9.9	1.4	68.3	49 to 77
Residents at Institution B	39	1.7	5.7	.9	70.4	65 to 73
Transfers to Institution Y	39	-4.5	3.7	.6	70.1	63 to 73

Age Groupings	Children	Net Changes in IQ			IQ	
		Mean	S.D.	$S.E._M$	Mean	Range
Residents in Institutions A and B						
Under six years	21	0.5	10.2	2.2	64.1	50 to 82
Seven to twelve years	76	.2	6.2	.7	70.3	56 to 98
Thirteen years and over	50	2.9	4.6	.7	68.2	59 to 73
Total all ages	147	2.3	7.0	.6	68.7	50 to 98
Residents and Transfers in Institutions X and Y						
Under six years	21	-4.3	11.0	2.6	64.3	49 to 81
Seven to twelve years	76	-5.5	5.6	.6	70.3	55 to 99
Thirteen years and over	50	-4.2	3.3	.5	68.4	62 to 76
Total all ages	147	-4.9	7.8	.6	68.8	49 to 99

They may be summarized in the statements below:

1. When children at Institutions A and B are paired with nontransfers at Institutions X and Y, the orphanage children tend to remain constant while the

children in the institution for the feeble-minded tend to lose. A significant difference of 6.0 IQ points is found between these paired groups. (Critical ratio, 4.5)

2. Comparison of residents of the two homes for dependents (A and B) and transfers from these homes to an institution for feeble-minded (X) shows a difference of 8.3 points, and is statistically significant. (Critical ratio, 4.4)

3. Residents at Institution A when paired with transfers from Institutions A and B to Institution Y indicate a significant difference (6.6 points) in favor of the orphanage group. (Critical ratio, 3.6)

4. When children at Institution B are paired with children transferred from the two homes for dependents to Institution Y, a similar significant difference may be noted. (Difference, 6.2 points; critical ratio, 5.7)

5. Regardless of age, the orphanage children continue to stay constant or gain while their pairs in schools for the feeble-minded tend to lose. In each case significant differences were obtained. (Differences, 12.8, 5.8, 7.1; respective critical ratios, 3.7, 6.1, 8.8)

6. Throwing all individuals from the orphanages who entered into pairings into one group, and similarly combining all the paired individuals in the schools for the feeble-minded, a total of 147 pairs is obtained. In such a composite some pairs doubtless are entered several times. Their number is not large enough, however, to influence to any great extent the total effect. The results show a reliable mean gain of 2.3 IQ points for the orphanage children, while their pairs in schools for the feeble-minded show a mean loss of -4.9. The difference is significant. (Difference, 7.2; critical ratio, 8.5)

These findings reveal a high degree of internal consistency. In every comparison there is a consistently significant difference between these carefully paired individuals in environments which differ at least 30 IQ points in mental level. In not a single comparison do the means of the orphanage groups show a loss, while a loss is indicated in every mean for the groups in the institutions for the feeble-minded. It should be remembered that in the homes for dependents these children represent the lower mental levels of the institutional population while in the schools for the feeble-minded those of similar IQ are in the higher strata. Seemingly, institutional environments of differing mental levels present unlike demands upon children of the same IQ, causing variations in the rate of mental development in accordance with the child's relative placement above or below the mental level of his environment. In other words it would appear that the average tends to set the "stimulation level" for the group, and children develop as the environment demands development. This conclusion is further substantiated in other findings in the larger study of which this investigation is a part (1).

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VALIDITY OF COMPARISONS OF CURRENT METHODS FOR ESTIMATING PHYSICAL STATUS

RAYMOND FRANZEN

A paper by Everett L. Marshall in the March 1937 number of "Child Development," prompts a brief discussion of the basic considerations which should control an evaluation of physical status estimates.[1]

There are three ways in which the discussion of this subject becomes confused. The paper used for purposes of illustration in this criticism is guilty of all of these. The departures from clear analysis are:

1. Failure to distinguish the severity of selection from the adequacy of the selection. Any method of measurement may be set to obtain any number of selections desired, but the main criterion for its value is the degree to which the selections which are made, represent what is claimed for them.
2. The assumption that "under-weight" is synonymous with "under-nourished."
3. The reference to popular abbreviated applications without due consideration of the basic published material which is their foundation.

DISTINCTION BETWEEN SEVERITY OF SELECTION AND ADEQUACY OF SELECTION

One of the comparisons made in the paper here used as illustration is between three methods of selection which use progressively more skeletal measures as control. The Baldwin-Wood tables are based on a height-weight correlation. The Pryor and Stoltz tables are based on the correlation of height and hips with weight.[2] The third method used in comparison is that of C. H. McCloy which uses *weight residuals from a still more inclusive skeletal arrangement.*

It is statistically obvious that the variability of the residuals in weight must grow progressively smaller as the skeletal elements in the correlated variable increase. This is best shown by comparison of the multiples and residuals involved as presented in the 1929 American Child Health Association Monograph on this subject.[3]

The real problem is not the shrinkage in variability (and this is all that is shown in Table I of Marshall's paper) but rather an evaluation by outside criteria of the cases which are part of a critical group (selected by standard deviation position or by percental methods). Studies have been made which arrive at such an evaluation and it can be shown that children selected by use of multiples containing skeletal measurements in addition to height are far more likely to be the type which physicians call undernourished than are those selected by either the Baldwin-Wood tables or the Pryor and Stoltz tables. From the point of view of

[1] Everett L. Marshall, "A Comparison of Four Current Methods of Estimating Physical Status."

[2] Pryor and Stoltz do not use the multiple but do derive a type of relationship. The multiple gives better results.

[3] Franzen, Raymond. "Physical Measures of Growth and Nutrition." Monograph II of the School Health Research Series. American Child Health Association, New York, 1929.

CHILD DEVELOPMENT, Vol. 8, No. 3 (September, 1937)

method, there is no distinction in this better type of weight selection between the one published by C. H. McCloy in 1936 and 1937 and the American Child Health Association method published in 1929, "Physical Measures of Growth and Nutrition."

The comparisons given by Marshall in Table II do attempt to show the overlap of selection but the error of unequal severity of selection makes conclusions from this table impossible. In order adequately to compare the methods, the measurements must be so set that each selects the same number of critical cases. This follows because the function we are trying to measure is a variable and not a category and any attempt to compare selections made by any two methods must insure the same rigor for each. One could obviously set a particular measurement to include 90% of the cases and then this would increase one's chances of overlap with other methods of selection enormously.

CONFUSION OF "UNDERWEIGHT" WITH "UNDERNOURISHED"

Marshall in his paper continuously refers to the ACH [1] as an estimate of "being underweight." This was, of course, never intended and should not be imputed as an objective. The estimate was purposely built to avoid the use of weight in the consideration of malnutrition. The reasons for this procedure are given in the monograph referred to above, which deals wholly with the matter of estimate of weight by multiples. The authors have produced tables for use in making weight estimates as residuals in a multiple regression and these are entirely independent of the ACH index.

The value of this index can in no sense be derived from a comparison with weight selections. An attempt has been made to evaluate selections in terms of a more inclusive anthropometric survey than is involved in either of the three methods quoted in the article under discussion. [2] This paper showed the degree of success by this type of estimate when compared with estimates of comparable severity in two of the other measurements under discussion. The objective was to find children who showed an overlapping deficiency in three criteria, - weight for skeletal build, arm girth for skeletal build, and subcutaneous tissue for skeletal build. When these three criteria are used in combination the ACH screen selection is far superior to that made by the two other methods. It netted 41 out of 43 (as yielded by an intensive survey of 500). This compares to 27 and 16 out of 43 netted by height-hip-weight and height-weight methods respectively.

More complete discussion of the adequacy of the use of the ACH for the selection of nutritional defects is contained in Chapter 7 of "Physical Defects, The Pathway to Correction," American Child Health Association 1934.

[1] Franzen, R. and Palmer, G. T. "The ACH Index of Nutritional status." New York American Child Health Association, 1934.

[2] Franzen, Raymond. "Selection of Malnourished School Children." American Journal of Diseases of Children, April 1934, Vol. 47, pp. 709-798.

CORRELATIONS OF PERCEPTION WITH OTHER ABILITIES AND TRAITS IN GRADE I[1]

FRANK T. WILSON AND CECILE WHITE FLEMMING

I. *INTRODUCTION*

During the school year 1933-34 a variety of tests was given to twenty-five children in Grade I of the Horace Mann School, Teachers College. These included tests of "reading readiness"; many of the Gates Reading Diagnosis tests; some reading achievement tests; mental ability tests, such as the Stanford Revision of the Binet-Simon tests and various performance tests; certain psychological tests, as of perception and perseveration; and several measures of psycho-physical and personality traits and of home background. The purpose of the study was to examine any possible relationships that might exist between measurable traits and abilities, and early progress in the mechanics of reading.

The children of the group came from well-to-do homes. A large percentage of the parents were professional people. The following averages for these pupils were found.

Chronological Age	6.31
Mental Age	7.61
Intelligence Quotient	120.6

Nearly every test and measurement was given or made individually, under carefully controlled conditions, and by reliable persons accustomed to administering tests to young children. The cooperation of the pupils was almost invariably excellent. It is believed for these reasons, that errors of examination were unusually low.

This report presents correlations of a perception test with about seventy other measures and appraisals used in the original study. An original test was devised in which the Graflex Vocal Plan Shutter Apparatus, (Stoelting Company) was used. The aperture was set at 1½, and the tension at 0-1. The adjustment plate indicated that this gave a reading of 10.

Thirty-two test cards, 6½ by 4½ inches, of white, unglazed cardboard were used for the stimulus symbols. The symbols were: horizontal lines; vertical lines; fowl silhouettes; heavy outlined triangles; the digits 2, 3, 4, 5, and 6; and the capital letters A, B, C, D, and E. The letters and numbers were in random order on their respective cards. There were four exposure cards each for the lines, triangles and silhouettes, and eight for both the numbers and the letters. For each kind of symbol, one card contained 2 symbols, one 3, one 4, and one 5, except that for both the numbers and the letters there were two cards with 2, 3, 4, or 5 symbols. The lines, letters, and figures were made in black India ink with a 1/8 inch wide lettering pen, they were about 5/8 of an inch in altitude, and were spaced about 1/2 to 5/8 of an inch apart. At the beginning of the experiment, the

[1] This report presents a minor phase of a study of Reading Readiness and Reading Progress in the Primary Grades of the Horace Mann School, Teachers College, New York, 1933-36. This study has been made possible by the cooperation of Miss Agnes Burke, Teacher of Grade I and other teachers of Kindergarten and Primary Grades. It has been made under the supervision of Doctor Cecile White Flemming, Director of Pupil Individual Development and Guidance, and of Doctor Rollo G. Reynolds, Principal. Prepared by F. T. Wilson, Department of Education, Hunter College, New York, with the assistance of the U. S. Works Progress Administration, New York City, project number 65-97-265, sub-project 25.

cards were shuffled and during the test were presented to every child in the order thus obtained. Two practice cards were used before the test was begun in order to familiarize the children with the purpose and method of the experiment. The first practice card had two fowls; the second, the letters X, A, and J. The description and order of the cards are shown in Table 1.

Table 1

Description of Perception Test Cards

				Order of Presentation of Test Cards
Practice	Card	a.	2 ducks (in silhouette)	
"	"	b.	X A J	
Test	"	1.	2 horizontal lines	31
"	"	2.	3 " "	20
"	"	3.	4 " "	19
"	"	4.	5 " "	11
"	"	5.	2 vertical lines	7
"	"	6.	3 " "	2
"	"	7.	4 " "	8
"	"	8.	5 " "	10
"	"	9.	2 hens (in silhouette)	16
"	"	10.	3 " (" ")	3
"	"	11.	3 roosters and 1 duck (in silhouette)..	29
"	"	12.	5 roosters (in silhouette)	17
"	"	13.	65	32
"	"	14.	462	6
"	"	15.	4362	25
"	"	16.	35642	9
"	"	17.	42	26
"	"	18.	243	15
"	"	19.	3246	23
"	"	20.	56243	14
"	"	21.	C E	5
"	"	22.	C E B	1
"	"	23.	A D B C	12
"	"	24.	E B A C D	20
"	"	25.	E D	18
"	"	26.	A E B	27
"	"	27.	C A E B	21
"	"	28.	C B D E A	4
"	"	29.	2 triangles (in heavy outline)	13
"	"	30.	3 " " " "	22
"	"	31.	4 " " " "	24
"	"	32.	5 " " " "	30

The child was seated in a comfortable chair with his back to the window. The apparatus stood on a table before him, the face slanting at an angle of about eighty-five degrees from the horizontal plane. The distance from the child's eyes to the aperture was about fourteen inches. The shutter was operated by a small hand lever trip. The cards were changed between exposures and, of course, were concealed from the child's view except during the instant of exposure. An assistant made the record of responses which were given orally in answer to the questions: "What do you see?" "How many?"

The score was the number of correct responses. In practically every case the symbols were correctly described, but the children varied in reporting the number of symbols perceived. The test seemed quite long for the children tested. A retest of nine children with half of the cards showed an agreement of 58% of responses with the first test for the same sixteen cards. Self-correlation of split halves for the entire test was .55.

The data of the study are in terms of correlations obtained by the rank order method. To secure the rank orders all measures and appraisals were reduced to numerical scores. Owing to lack of facilities, it was not feasible to make all the computations that were possible in the original study. A "finder" device was

used to select for computation the correlations which seemed to promise significance. It is believed that through the use of this device, although it was not altogether accurate, all the high and fairly high correlations were found. The correlations omitted were probably below .50, and most of them probably nearer zero than .50. The P.E. of rho's when N = 25, range from ± .0237 for .90 to ± .1335 for .10.

The validity of many of the measures and appraisals is uncertain. Few correlations of seemingly unusual size were obtained, however, and few which were inconsistent with other correlations for the same kind of traits and abilities found in the complete data of the original study. The opinion of the teacher, of the school psychologist, and of other qualified persons who have studied the figures, is that the results have quite high validity.

II. FINDINGS

List 1 shows all the computed correlations of perception with the other tests in order of size. None of these correlations is very high. Those for Metropolitan similarities and for total matching, .47 and .45 respectively, are about what would be expected from the nature of the abilities involved in the tests. The similarities test required visual perception of similarities and differences. The matching tests required much the same sort of visual perception.

The correlation -.46 with the Gates Diagnosis Test, XI, 2, plus supplement, which required the recognition of two spoken words as being the same or different words, does not seem to be explicable on any grounds but chance. This test was auditory. The perception test was visual. That there should be fairly high negative correlation between these differing abilities is hardly probable.

List 1

Correlations of Perception with 73 Other Measures

Metropolitan Readiness Test, Similarities	.47
Total matching	.45
Hildreth First Grade Reading Analysis Test, Matching phrases	.42
Hildreth First Grade Reading Analysis Test, Matching sentences	.38
Gates Reading Diagnosis Tests, XV, 1, Memory span, digits	.37
Grip	.37
Gates Reading Diagnosis Tests, XV, 3, Memory span, nonsense syllables	.36
Seguin, Form Board Time	.36
Manikin, Pintner-Patterson, Time	.35
Metropolitan Readiness Test, Copying	.34
Metropolitan Readiness Test, Information	.34
Stone & Grover Classification Test for Beginners in Reading II	.33
Healy Picture Completion Test, II	.33
Van Wagenen Reading Readiness Test, Word learning	.32
Gates Reading Diagnosis Tests, XV, Total memory span	.31
Nutrition (variation from height-weight-age norms)	.31
Reversals, Auditory perception	.31
Hildreth First Grade Reading Analysis Test, Total	.30
Weight	.30
Gates Reading Diagnosis Tests, XV, 4 Memory span words	.29
Stone & Grover, Classification Test for Beginners in Reading, Total	.29
Teacher's Ranking in Reading, November prediction	.28
Gates Reading Diagnosis Tests, IX, 1-7 & 9. Phonic combinations and letter sounds	.28
Undesirable behavior traits	.27
Gates Reading Diagnosis Tests, IX, 9, Giving letter sounds	.27
Motor Coordination (Battery of six tests)	.26
Hildreth First Grade Reading Analysis Test, Matching words and phrases	.26
Teacher's Ranking in Reading, May	.24
Gates Reading Diagnosis Tests, IX, 1-7, Giving phonic combinations	.23
Gates Reading Diagnosis Tests, VIII, 3, Word recognition, auditory perception	.23
Gates Primary Reading Tests, Type 1, Word recognition, March	.22
Gates Primary Reading Tests, Type 2, Sentence reading, May	.22
Gates Primary Reading Tests, Type 2, Sentence reading, March	.21
Metropolitan Readiness Test, Total	.21

List 1 - Continued

Correlations of Perception with 73 Other Measures

Van Wagenen Reading Readiness Test, Memory span	.21
Van Wagenen Reading Readiness Test, Information	.20
Hildreth First Grade Reading Analysis Test, Matching words	.20
Gates Reading Diagnosis Tests, XV, 2, Memory span, letters	.19
Perseveration, Elkins-Maller, Attention Test	.19
Mare & Foal, Time	.18
Gates Reading Diagnosis Tests, XIII, 3, Adapted, Writing capital and small letters and digits	.17
Tapping, Whipple and Healy	.16
Van Wagenen Reading Readiness Test, Relations	.14
Gates Primary Reading Tests, Type 1, Word recognition, May	.14
Gates Primary Reading Tests, Type 3, Paragraph reading, May	.12
Metropolitan Readiness Test, Drawing man	.11
Gates Reading Diagnosis Tests, XIII, 1-2, Write words	.11
Ship Test	.09
Chronological Age	.08
Nervousness Index	.07
Developmental Index (babyhood)	.06
Van Wagenen Reading Readiness Test, Vocabulary	.05
Personal Traits	.05
Gates Reading Diagnosis Tests, X, 1, Blend letters	.11
Gates Reading Diagnosis Tests, IX, 10, Recognition capital letters	.05
Reversals, Visual perception	.04
Van Wagenen Reading Readiness Test, Word discrimination	.03
Total, Vocabulary Time	.03
Gates Primary Reading Tests, Type 3, Paragraph reading, March	.03
Metropolitan Readiness Test, Vocabulary	.03
Mental Age, Stanford Revision of the Binet-Simon	.02
Stone & Grover, Classification Test for Beginners in Reading I	.02
Gates Primary Reading Tests, Type 1, Word recognition, November	.02
Gates Reading Diagnosis Tests, VIII, 2, Word recognition, visual presentation	.01
Metropolitan Readiness Test, Numbers	-.001
Total Vocabulary	-.004
Perseveration, Elkins-Maller, Attention Test	-.03
Total Errors	-.03
Gates Reading Diagnosis Tests, IX, 11, Recognition small letters	-.04
Parent Questionnaire, No. of Activities, Total	-.04
Intelligence Quotient, Stanford Revision of the Binet-Simon	-.07
Steadiness (hole apparatus)	-.08
Gates Reading Diagnosis Tests, X, 2, Recognition sounded letters	-.08
Mare & Foal, Errors	-.08
Personality Rating, Hicks, A Personality Rating Scale for Children Six to Nine	-.09
Height	-.09
Gates Reading Diagnosis Tests, XI, 2, Same-different words	-.12
Writing Time	-.14
Metropolitan Readiness Test, Sentences	-.15
Gates Reading Diagnosis Tests, X, Total, Auditory perception	-.18
Gates Reading Diagnosis Tests, XI, 1, Repeat nonsense syllables	-.20
Gates Reading Diagnosis Tests, X, 3-4, Giving initial and final sounds	-.21
Gates Reading Diagnosis Tests, XI, 2 and supplement, Same-different words	-.46
Average	.138

Lists 2 to 8 give correlations of perception with groupings of other measures. List 2 shows the correlations of perception with fourteen reading tests. Only two of these correlations are even fairly high, namely, .42 and .38. Both are for subtests of the Hildreth First Grade Reading Analysis Test, one requiring matching phrases and the other matching of sentences. The total of this test had a correlation of .30 with perception. The teacher's rankings in reading for November and May gave correlations of .28 and .24, respectively. None of the reading tests had negative correlations with perception, although the two lowest ones were .02 and .03. The average for the fourteen correlations was .217, and the range was from .02 to .42. Some but not very close relationship between the perception and reading tests is indicated.

List 3 gives the correlations between the perception test and tests of abilities with letters. There are five negative correlations in this list. All of these are for letter tests involving sounds and requiring no use of the eyes. One other test in this group of abilities with letters, a memory span test, was

List 2

Correlations of Perception with 14 Reading Tests

Gates Primary Reading Tests, Type 1, Word recognition, November	.02
" " " " " 1, Word recognition, March	.22
" " " " " 2, Sentence reading, March	.21
" " " " " 3, Paragraph reading, March	.03
Hildreth First Grade Reading Analysis Test, Matching phrases	.42
" " " " " " Matching words	.20
" " " " " " Matching sentences	.38
" " " " " " Matching words and phrases in sentences	.26
Total " " " " "	.30
Teacher's ranking in reading, November prediction	.20
" " " " May, ability	.34
Gates Primary Reading Tests, Type 1, Word recognition, May	.14
" " " " " 2, Sentence reading, May	.22
" " " " " 3, Paragraph reading, May	.12
Average	.217
Range .02 to .42	

List 3

Correlations of Perception with 17 Tests of Letter Abilities

Stone & Grover, Classification Test for Beginners in Reading I	.02
" " " " " " " " " II	.33
Gates Reading Diagnosis Tests, VIII, 2, Recognition of words seen	.01
" " " " VIII, 3, " " " heard	.23
" " " " IX, 1-7 Phonic combinations	.23
" " " " IX, 9, Giving letter sounds	.27
" " " " IX, Total 1-7 and 9	.28
" " " " X, 1, Blend words	.11
" " " " X, 2, Recognition sounded letters	-.05
" " " " X, 3-4, Giving initial and final sounds	-.21
" " " " X, Total auditory perception	-.10
" " " " XIII, 1-2, Writing words	.11
" " " " XIII, 3, Writing letters	.17
" " " " *IX, 10, Recognition capital letters*	.05
" " " " XI, 2, Recognition same-different words	-.12
" " " " XI, 2, plus supplement	-.46
" " " " XV, 2, Memory span, letters	.19
Average	.058
Range -.46 to .33	

List 4

Correlations of Perception with 20 Tests of Mental Ability

Van Wagenen Reading Readiness Test, Information	.20
" " " " " *Relations*	.14
" " " " " Vocabulary	.05
" " " " " Memory span	.21
Metropolitan Readiness Tests, Vocabulary	.03
" " " *Sentences*	-.15
" " " Numbers	.00
" " " Information	.34
" " " Drawing Man	.11
Gates Reading Diagnosis Tests, XI, 1, Repeat nonsense syllables	-.20
Vocabulary, Time (Binet, Action-Agent, Kindergarten Word List)	.00
Seguin Form Board	.36
Mare & Foal, Time	.10
Mare & Foal, Errors	-.00
Manikin	.35
Ship Test	.0[illegible]
Healy Picture Completion Test, II	.3[illegible]
Mental Age (Binet)	.02
Intelligence Quotient (Binet)	-.07
Gates Reading Diagnosis Tests, XV, 1-4 Total memory span	.31
Average	.[illegible]
Range -.20 to .36	

List 5

Correlations of Perception with 14 Psycho-Physical Measures

Total Writing Time	-.14
" Vocabulary Time (Binet, Action-Agent, Kindergarten Word List	.03
Steadiness (hole test)	-.08
Tapping Whipple-Healy	.16
Perseveration, Elkins-Waller, Attention Test, Second test	.19
Chronological Age	.08
Grip	.37
Perseveration Elkins-Waller Attention Test, First test	-.03
Motor Coordination (6 tests)	.26
Weight	.30
Height	.09
Nutrition	.11
Total Number Activities, parent questionnaire	-.04
Developmental Index (Babyhood)	.06
Average	.099
Range -.14 to .37	

List 6

Correlations of Perception with 7 Personality Measures

Reversals, Visual perception	.04
" Auditory perception	.31
Total Errors (9 tests)	-.03
Undesirable behavior traits, parent questionnaire	.27
Personal Traits	.06
Personality Rating, Hicks, A Personality Rating Scale for Children Six to Nine	-.09
Nervousness Index, parent questionnaire	.07
Average	.089
Range -.09 to .31	

also non-visual. It correlated .19 with the perception test. Of the twelve visual tests, two correlated .02 and .01 with the perception test. They were Part I of the Stone and Grover Classification Test and the Gates Reading Diagnosis subtest for recognition of words seen. In both of these tests the children were to compare printed words. The average for all of the seventeen correlations of the list was .056, and the range was from -.46 to .33. Quite varied, but in the main not close, relationships between the perception test and the letter ability measures is indicated by these figures.

The twenty correlations of perception with tests of mental ability, shown in List 4, ranged from -.20 to .36 and averaged .078. Three performance tests, namely the Seguin Form Board, Manikin, and Healy Picture Completion Test II, correlated .36, .35 and .33, respectively. M. A. correlated .02 and I. Q. -.07. None of the correlations seems of special importance.

The correlations of fourteen psycho-physical measures with perception, given in List 5, ranged from -.14 to .37 and averaged .099. The highest, .37 was for grip. C. A. correlated .08 and a composite score for developmental index (in babyhood), .06. There seems to be little evidence of significant relationships between the perception test and the abilities and traits in this group of measures.

List 6 gives correlations with seven personality measures. None of these is high enough to suggest any relationship of consequence.

SUMMARY AND CONCLUSION

A test of perception by an exposure apparatus, with twenty-five Grade I chil-

dren, yielded a few fairly high correlations with some visual matching tests. The average of correlations of the perception test with 14 reading tests was .217; with 17 letter tests, .056; with 20 mental tests, .078; with 14 psycho-physical measures, .099; and with 7 personality measures, .089.

These results indicate very moderate degree of relationship between perception, as measured, and tested reading abilities, and varied degrees of relationship, ranging from moderate to little or none, between perception, as measured, and tested abilities with letters, and with measured and estimated mental, psycho-physical, and personality traits.

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CORRELATIONS OF MEMORY SPAN WITH OTHER ABILITIES AND TRAITS IN GRADE I

This report presents correlations derived from six measures of memory span with seventy-six other measures and appraisals of the pupils. The Memory Span Tests were:

1. A sub-test of the Van Wagenen Reading Readiness Tests called "Memory Span for Ideas." This consisted of twenty-five sentences of increasing length. The first sentence was: "Children like to play with dogs and cats"; the second: "He may get new shoes for Christmas"; and the others were of like nature.

2. The Gates Diagnosis Reading Tests, XV, Memory Span, consisting of four parts: digits, letters, nonsense syllables and familiar words.

3. Gates Diagnosis Reading Tests, sub-test XI, 1, Repeating Nonsense Words. This test was given as a memory span test of syllables, not as a test of nonsense words, which is the purpose of the test according to the directions. The syllables were successions of miscellaneous short familiar words and short meaningless syllables, as for example, "ho-min-us" "du-ran-gib-a-lin," etc. The number of syllables increases from two to six as progress is made thru the test. This test will be called the mixed syllables test in the report.

The test scores used in the study were:

1. For the Van Wagenen Test, the score value shown in the test directions.

2. For the Gates Diagnosis Tests, the length of the memory span in each part of the test; and a total score made by summing the scores of the four parts of the tests.

The data of the study are in terms of averages and correlations obtained by the rank order method. To secure the rank orders all measures and appraisals were reduced to numerical scores. Owing to lack of facilities, it was not feasible to make all the computations that were possible in the original study. A "finder" device was used to select for computation the correlations which seemed to promise significance. It is believed that through the use of this device, although it was not altogether accurate, all the high and fairly high correlations were found. The correlations omitted were probably below .50, and most of them probably nearer zero than .50. Representative P. E.'s of rho's, when N = 25, are given in Table 2.

The validity of many of the measures and appraisals is uncertain. Few correlations of seemingly unusual size were obtained, however, and few which were inconsistent with other correlations for the same kind of traits and abilities as found in the complete data of the original study. The unanimous opinion of the teacher, of the school psychologist, and of other qualified persons who have studied the figures, is that the results have quite high validity.

II. FINDINGS

A - INTERCORRELATIONS

Table 1 shows the intercorrelations of the six memory span tests with each other. The average of all of the fifteen coefficients of intercorrelations of the subtests is .53. The highest intercorrelations are, naturally, those of the Gates total memory span test score with the several parts that make up that total score. They range from .71 ± .064 to .88 ± .0283. The intercorrelations of the separate tests ranged from .29 ± .122, to .71 ± .064. The latter was the coefficient for the letters and digits tests. The large P. E.'s and the varied sizes of the intercorrelations indicate lack of high reliability for the measures. The intercorrelations of the two tests using senseless syllables, namely the test for nonsense syllables and that of mixed short words and meaningless syllables, gave

Table 1

Intercorrelations of Memory Span Tests

		Gates Reading Diagnosis Tests						
	Van Wagenen Sentences (1)	Digits (2)	Letters (3)	Nonsense Syllables (4)	Fam. Words (5)	Mixed Syll. (6)	Gates Total* Col.2-5 (7)	Ave. Col.1-6 (8)
Van Wagenen, Sentence Memory Span	--	.59	.42	.42	.49	.68	.69	.52
Gates, Digits	.59	--	.71	.57	.63	.49	.88	.598
Gates, Letters	.42	.71	--	.54	.52	.43	.81	.524
Gates, Nonsense Syllables	.42	.57	.54	--	.60	.29	.79	.484
Gates, Familiar Words	.49	.63	.52	.60	--	.55	.71	.558
Mixed Syllables	.68	.49	.53	.29	.55	--	.43	.49
Average	.52	.598	.524	.484	.558	.49		
*Gates Total, Digits, Letters, Nonsense Syllables, Familiar Words	.54	.88	.81	.79	.71	.43	.693	

Frequency Distribution of Table 1, Excluding Averages and Totals

.70 to .79	1
.60 to .69	3
.50 to .59	5
.40 to .49	5
.30 to .39	0
.20 to .29	1
	15

Average = .53 S. D. = ± .117

Table 2

P. E. of Representative RHO Correlations when N = 25 are as Follows:

Rho		P. E.	Rho		P. E.
.90	±	.025	.55	±	.091
.85	±	.035	.50	±	.099
.80	±	.046	.40	±	.112
.75	±	.056	.30	±	.122
.70	±	.066	.20	±	.129
.65	±	.075	.10	±	.134
.60	±	.083			

the rather surprisingly low figure .29. The remaining intercorrelations of the mixed syllables test with the other tests ranged from .43 to .68, the highest being with the sentence span. The coefficient for mixed syllables test and the total of the Gates tests was .43. The average of the intercorrelations of this test with the other tests, .49, is not appreciably different from the averages of the other tests.

It might be supposed that close similarity in test materials would have produced higher intercorrelations than tests of dissimilar materials. For example, since sentences are made up of words perhaps the intercorrelation between the sentence test and the familiar word test would be higher than most of the other intercorrelations. This coefficient is .49, however, as compared with .59 for the correlation of sentences and digits, and .68 for that of sentences and mixed syllables. Again, words are composed of letters, but that similarity failed noticeably to affect the intercorrelation between the tests using words and letters, as the coefficient, .52, is practically the same as the average of the entire fifteen intercorrelations, which was .53. The highest intercorrelation, .71, was for letters and digits. Possibly the similarity in form - short and simple - rather than similarity in content made that relationship somewhat closer. The wide variation in the figures of the table seems to indicate that the abilities concerned were not simple or unitary abilities but complex ones, probably involving many factors which varied greatly from one test situation to another.

9 - AVERAGES

Averages, standard deviations, and probable errors of the averages of the several memory span tests are shown in Table 3 for two groups.

Table 3

Average Scores of Memory Span Tests Grade I Pupils, Groups A and F

	Average		S. D.		P.E. Average	
Groups	A	F	A	F	A	F
Time Tested	Fall	Spring				
Number Pupils	25	30				
Van Wagenen						
Sentences	44.70		11.77		1.59	
Gates Diagnosis						
Digits	5.90		.90		.132	
Letters	4.90	5.31	.954	.895	.115	.108
Nonsense Syllables	4.66		.704		.106	
Familiar Words	4.70	4.06	.67	.542	.086	.066
Mixed Syllables	5.26		.861		.116	
Total*	18.86		2.726		.306	

*Total Digits, Letters, Familiar words, and Nonsense Syllables tests of the Gates Reading Diagnosis Tests.

All of the terms are given for Group A, which was the grade studied intensively in this investigation. They are given only for the letter and word tests for the other group, Group F. Comparison of the averages made by Group A, in the Gates sub-tests shows that the averages for the digits test was highest, 5.90. The average for the mixed syllables test was next highest, 5.26; then that for letters, 4.98; next that for familiar words, 4.78; and last that for nonsense syllables 4.66. It will be noted that the average spans for group F were very nearly the same as those for Group A. The letter span of this group was .33 of a unit longer than the letter span for Group A; and the familiar word span was .12 of a unit longer. When allowance is made for the later date at which the F group was tested

the differences seem to be of little or no significance.

The standard deviations were quite large for all tests, varying from ±.64 to ±.90 for the Gates subtests. The P. E.'s of the averages for these subtests were also quite large, ±.096 to ±.132. It is interesting to note that the largest S. D. and P. E. of the average in this group of tests was for the digits test - which gave the highest average and which seemed, according to the table of intercorrelations, to be the most reliable subtest. On the other hand the smallest S. D. and P. E. of the average were for the familiar word test. This test gave next to the lowest average in the Gates group. It also gave average intercorrelations (Table 1) with all the other tests that were almost as high as those given by the digits test. Table 3 shows that, for these children, the variability in the abilities involved in the tests was very large.

Table 4 gives the critical ratios for the differences between the averages of the four subtests of the Gates tests. The table shows that only the differences

Table 4

The Critical Ratio's of the Differences Between the Averages of the Gates Memory Span Subtests, Grade I Pupils

	Group	Differences between Averages	Critical ratios
Digits less Letters	A	.92	3.54
" " Nonsense Syllables	A	1.24	4.94
" " Familiar Words	A	1.12	4.73
" " Mixed Syllables	A	.64	2.45
Letters less Nonsense Syllables	A	.32	1.38
" " Familiar Words	A	.20	.92
" " " "	F	.45	2.39
" " Mixed Syllables	A	-.28	1.15
Nonsense Syllables less Familiar Words	A	-.12	0.50
Nonsense Syllables less Mixed Syllables	A	-.60	2.50
Familiar Words less Mixed Syllables	A	-.48	2.20

between the digits test and each of the letters, nonsense syllables and familiar word tests are statistically significant. A possible explanation for this fact is that digits may be easier to keep in immediate memory than the other test material. Their written form is simple and the associations of that form with the verbal form may be closer. Perhaps memory images aided the children in holding the spans in mind. There are but nine common visual forms for the nine digits, while there are at least fifty-two common printed plus additional script forms for the twenty six letters. Memory images of words and syllables would probably be still less helpful that those of letters to young children.

The score for the Van Wagenen Memory Span test for sentences was derived from the count of the number of sentences correctly repeated by the subject. The average score for the group, 44.7, corresponds to a total of fifteen sentences repeated correctly. The sentences of the test are numbered consecutively. Fifteen correct does not mean, necessarily, that the sentence numbered fifteen was the longest one which, on the average, the children could repeat. It does seem reasonable, however, to take that sentence as the measure of average ability of the group. This sentence is, "When it storms hard I have to stay in the house to keep dry." This is fourteen syllables long. Van Wagenen entitled this test, "Memory Span for Ideas," but gave no count in either the test or manual of the number of ideas in any of the sentences. The inserted check marks indicate what seem obviously to be five main ideas. Sentence 1 and some others in the test

seem to contain four main ideas. Most of the remainder up to and including sentence 14 contain five, six or seven ideas. Sentence 16 has five ideas; sentence 17, seven; and sentence 18, eight. The rest have more. If this analysis is reasonably close to the facts it would seem to show that the memory span of these children for ideas was at least five and perhaps six or more. This is about the same as, or perhaps a little more than, the average for the digits test, which was the longest of the four Gates subtests.

The intercorrelations of this sentence test with the tests of the other types of memory span, (Table 1) were practically the same as those of the others, with two exceptions. The intercorrelation of the sentence test with the mixed syllables test, .68, is higher than those of the other types of tests and mixed syllables (column 6, Table 1). The intercorrelation with letters, .42, is lower than those of the other tests and letters (column 3, Table 1). These differences may be chance differences due to the small number of cases.

In conclusion, regarding the effect of the kind of test material used, it seems that analysis of intercorrelations and averages gives no grounds for believing that close similarity of content material of the tests produced any appreciable similarity in measurable abilities of so-called memory span.

The order of the length of average memory spans for 18 of the former 25 grade I children when retested in the spring of their grade III year was, with one exception, the same as on the first test. The digit span was the longest, the let-

Table 4a

Averages, S. D.'s and P. E.'s of Averages for 18 of the Same Children Retested with the Gates Subtests after 27 Months

	Average	S. D.	P. E. Average
Digits	6.11	.890	.142
Letters	5.70	.989	.157
Nonsense syllables	4.72	.711	.119
Familiar words	5.11	.890	.142
Mixed syllables	5.56	.840	.135
Total*	20.22	2.844	.452

*Total digits, letters, familiar words, and nonsense syllables tests.

ter span was second instead of third, the mixed syllables third instead of second, familiar words next, and nonsense syllables shortest. There is substantial agreement between the critical ratios for the Grade III and Grade I test results. The

Table 4b

Critical Ratios of the Differences Between the Averages of the Gates Memory Span Subtests for 18 of the Children Tested 27 Months Apart

Differences between	Critical Ratios Spring 1936 Grade III	Critical Ratios Dec. 1933 Grade I
Digits and Letters	1.06	[illegible]
" " Nonsense Syllables	5.15	[illegible]
" " Familiar Words	3.77	[illegible]
" " Mixed Syllables	1.90	1.18
Letters and Nonsense Syllables	3.11	1.27
" " Familiar Words	2.15	1.19
" " Mixed Syllables	.72	1.05
Nonsense Syllables and Familiar Words	1.44	[illegible]
" " " Mixed Syllables	[illegible]	[illegible]
Familiar Words and Mixed Syllables	1.55	[illegible]

Table 4a

Differences and Critical Ratios Between the Averages of the Grade I and Grade III Scores made by the 18 Children in the Gates Subtests

	Averages		Differences	S.D. dif-ferences	Critical ratios
	Grade I	Grade III			
Digits	5.70	6.11	.33	.303	1.099
Letters	5.06	5.78	.72	.303	2.376
Nonsense syllables	4.72	4.72	.00		0.000
Familiar words	4.78	5.11	.33	.248	1.331
Mixed syllables	5.39	5.56	.17	.318	0.534
Total*	18.03	20.22	1.39	.880	1.580

*Total digits, letters, nonsense syllables, and familiar words tests.

differences between digits and nonsense syllables and between digits and familiar words remained reliable in Grade III. The difference between letters and nonsense syllables, was reliable in Grade III, but not in Grade I. Perhaps the greater familiarity with letters, which the children had acquired by Grade III, made it easier than it had been 27 months before to use the memory image of the letters in holding the letter span in mind. The difference between nonsense syllables and mixed syllables was likewise reliable in Grade III, although it had not been so in Grade I. Familiarity of the symbols could scarcely have been a factor in this instance. Possibly this was an instance of unusual chance result. No reliable differences between Grade I and Grade III abilities is shown by these ratios.

C - CORRELATIONS WITH OTHER MEASURES

Table 5 gives the ninety-two computed correlations of the memory span test with a group of tests, which logically seem to belong together under the general descriptions of "mental tests". The mental measures included parts of the Van Wagenen test, such as information, relationship, and vocabulary tests; all the subtests of the Metropolitan test; the total vocabulary test; performance tests; Binet mental age; and Binet intelligence quotient. The average of all the correlations as derived from the frequency table, was .448; the standard deviation, ±.160. The averages of the correlations of the several memory span tests with the mental tests ranged from .276 to .575.

The averages of the various memory span tests shown were not derived in every instance from correlations of exactly the same mental measures, but that fact does not explain the variations in the sizes of the several averages. Even greater variations appeared among the correlations of particular mental measures with the various memory span tests. For example, the Metropolitan copying test produced correlations with the seven memory span tests ranging from .28 to .72. The Metropolitan Total gave correlations varying from .32 to .68.

It might be supposed that the averages of Table 5 would show tendencies for certain types of memory span material, rather than others, to be more closely related to abilities measured in mental tests. In order of size the averages of the correlations for the different types of test were: sentences, .575; digits, .562; mixed syllables, .470; familiar words, .421; letters, .417; and nonsense syllables, .276. The sentence and digit tests gave the highest averages. Possibly the materials of these tests were more closely related to the materials of the mental abilities tested than were those of the other types of memory span. However, when the individual correlations are considered the variations and exceptions were very

Table 5

Correlations of Memory Span Tests with Mental Measures *

	Van Wagenen Sentences	Gates Reading Diagnosis Tests: Digits	Letters	Nonsense Syllables	Fam. Words	Total Col.2-5	Mixed Syllables
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Van Wagenen, Information	.58	--	.32	.15	.45	.28	.55
Van Wagenen, Relations	.64	--	.30	.21	.34	.30	.61
Van Wagenen, Vocabulary	.70	.55	.32	.35	.37	.43	.61
**Metropolitan, Similarities	.39	.63	.46	.26	.45	.51	.26
Metropolitan, Copying	.47	.72	.49	.28	.41	.54	.35
Metropolitan, Vocabulary	.59	--	.39	.32	.52	.34	.66
Metropolitan, Sentences	--	.43	.26	.13	.50	.31	.36
Metropolitan, Numbers	.58	.54	.44	.33	.46	.50	.75
Metropolitan, Information	.66	.50	.47	.42	.41	.50	.43
Metropolitan, Total	.68	.67	.55	.32	.54	.58	.67
Metropolitan, Drawing	--	.55	.37	.25	.62	.41	.39
Vocabulary	.53	--	.29	.24	.05	--	.55
Seguin Form Board, Time	--	.32	.36	.11	.30	--	.07
Mare and Foal, Time	--	.73	.66	.33	.47	.60	.25
Mare and Foal, Errors	--	.54	.41	--	.44	.42	.20
Mental Age	.54	.55	.53	.29	.39	.49	.72
Intelligence Quotient	.54	.51	.46	.43	.36	.53	.56
Averages	.575	.562	.417	.276	.421	.455	.470
Ranges	.39 to .70	.32 to .73	.26 to .66	.11 to .43	.05 to .62	.28 to .60	.07 to .75

*The dashes in the columns of the table mean that the correlations were not computed because the "finder" device indicated that they would not be high.
**Metropolitan Reading Tests for First Grade and Kindergarten.

Frequency Table of Above Correlations, Excluding Totals

.70 to .79	5	.30 to .39	21		
.60 " .69	11	.20 " .29	11	Ave.	= .448
.50 " .59	21	.10 " .19	3	S. D.	= ± .16
.40 " .49	18	0 " .09	2		
			92		

great. For example, the computed correlations for the sentence and mental tests ranged from .39 to .70; those for the digits test from .32 to .73. The highest individual correlation in Table 5, .75, was for the mixed syllables and Metropolitan numbers tests.

The average of the correlations of the nonsense syllables and the mental tests, .276, was much lower than those for either sentences or digits and the mental tests. Sixteen coefficients were computed and ranged from .11 to .43. The reliability of the nonsense syllables tests as indicated by the average of five intercorrelations, (Table 1, column 4), was a little lower than those for sentence and digits tests. This lower reliability of the test might have reduced the size of the correlations with the mental tests below those of the sentence and digit tests. This explanation loses force, however, when the results of the mixed syllables test are examined. That test had practically the same average for intercorrelations (Table 1, column 6), as did the nonsense syllables. Its correlations with the mental tests, however, averaged nearly as much, .470, as did the sentence and digit tests, .575 and .562, respectively, although the variability was greater, .07 to .75. It seems that many uncontrolled factors operated in the test situations.

In Table 6 are shown the sixty-one computed correlations of the memory span subtests, and eleven correlations of the total memory span test, with a variety of reading tests. The average of the sixty-one correlations of this group, as derived from the frequency table, was .357, the standard deviation ±.151. The averages of the several memory span tests ran from .188 to .546. These averages are a little lower than those for the mental tests. There seemed to be tendencies for the subtests for digits and mixed syllables to correlate higher with reading tests than the other subtests. The averages of the coefficients for each of these tests were about 20-30 points higher than the averages for the letters, familiar words, nonsense syllables and sentences tests. Similarity in the content of the sentence and word memory span subtests and that of the reading tests did not affect the size of the correlations of those tests with reading. In fact, some of the coefficients for the correlations of reading with sentence and word memory span tests were quite small. For instance, the teacher's estimate of pupils' ability to read in May gave a correlation of only .24 with the word memory span test, and .23 with the sentence test, whereas it was .42 with the digits, .38 with the letter tests, and .49 with the mixed syllables test. The May Gates Primary Reading Test, Type 3, Paragraph reading, gave .26 with the

Table 6

Correlations of Memory Span Tests with Reading Tests*

	Van Wagenen Sentences	Gates Diagnosis Reading Tests					
		Digits	Letters	Nonsense Syllables	Familiar Words	Total Col.2-5	Mixed Syllables
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
**Gates Primary Reading Tests Type 1, November	--	--	.11	.01	.31	-.02	.50
Gates Primary Reading Tests Type 1, March	.20	--	.14	-.01	.06	--	--
Gates Primary Reading Tests Type 2, March	--	.50	.55	.24	.45	.48	--
Gates Primary Reading Tests Type 3, March	--	.42	.51	.22	.43	.43	.51
#Hildreth, Matching Words	.43	.63	.33	.31	.37	.46	--
Hildreth, Matching Sentences	--	.46	.18	.19	.39	.30	--
Hildreth, Matching Words and Phrases in Sentences	--	.54	.42	.20	.31	.40	--
Hildreth, Total	.40	.59	.35	.30	.35	.44	--
Teacher's Ranking, November	.46	.49	.41	.21	.32	.40	.65
Teacher's Ranking, May	.23	.42	.30	.10	.24	.34	.49
Gates Primary Reading Tests Type 1, May	.34	.58	.43	.21	.30	.43	.58
Gates Primary Reading Tests Type 2, May	--	--	.38	.15	.12	--	--
Gates Primary Reading Tests Type 3, May	.33	.49	.36	.24	.26	.41	--
Averages	.341	.512	.35	.188	.301	.37	.546

*(See footnote - table 5)
**Gates Primary Reading Tests - Type 1, Word Recognition; Type 2, Sentence Reading; Type 3, Paragraph Reading.
#Hildreth First Grade Reading Analysis Tests

Frequency Table of Above Correlations, Excluding Totals

.60 to .69	2	.20 to .29	10
.50 " .59	9	.10 " .19	7
.40 " .49	14	.00 " .09	2
.30 " .39	16	-.00 " -.09	1
			61

Average = .357 S.D. = ± .151

familiar word memory span test, .33 with sentences, .49 with digits and .36 with letters. The same contrast is shown by the May Gates Primary Reading Tests, Type 1, word recognition, which gave correlations of .30 with familiar words, and .34 with sentence memory span tests, as compared with .58 for the word recognition test and digits and .43 for the word recognition test and letters. The large P. E.'s reduce the statistical significance of the differences between these coefficients.

Table 7 gives the forty-nine computed correlations of the memory span subtests with a variety of letter tests and the seven correlations of the Gates total with letter tests. The average of the forty-nine correlations as derived from the frequency table was .37; the standard deviation ±.167. The averages for the various memory span subtests ran from .228 to .506. The averages of the several memory span tests with various tests of letter abilities show one possible tendency, namely that the familiar word and the nonsense syllables memory span tests correlated lower with letter tests than did the other memory span subtests. For example, the correlations of the familiar words tests with the tests of recognition of phonic combinations, capital letters and small letters, were very low, .14, .16 and .18, respectively. The averages for the Van Wagenen sentences and the Gates digits and mixed syllables tests may be higher than would have been the case if all the correlations had been computed. Columns 1, 2 and 7 in table 7

Table 7

Correlations of Memory Span Tests with Letter Tests*

Letter Tests	Van Wagenen Sentences (1)	Gates Reading Diagnosis Tests: Digits (2)	Letters (3)	Nonsense Syllables (4)	Fam. Words (5)	Total Col.2-5 (6)	Mixed Syllables (7)
**Stone, Pt.I	--	--	.46	.19	--	.26	--
#Gates Subtests							
IX, 1-7 Phonic combinations	--	--	.20	.20	.14	.24	--
VIII, 3 Word recognition	--	--	.26	--	.23	--	--
VIII, 2 Word recognition	.50	.52	.42	.44	.39	.50	--
IX, 9 Giving letter sounds	.45	.41	.39	.43	.31	.45	.56
X, 1 Recognition blended words	--	--	.13	.17	.25	--	--
X, 2 Recognition sounded letters	--	--	.09	.20	.03	--	.47
X, 3-4 Giving initial and final sounds	--	.47	.51	.27	.23	.42	.66
XIII,1-2 Writing words	.34	--	.23	.22	.34	.30	.70
XIII, 3 Writing letters	.40	.59	.54	.30	--	.50	.61
IX, 10 Recognition capital letters	--	.49	.52	.15	.30	--	.43
IX, 11 Recognition small letters	--	--	.45	.33	.10	--	.55
Averages	.403	.478	.357	.275	.228	.303	.536

*See footnote in Table 5.
**Stone and Grover Classification Test for Beginners in Reading
\# Gates Reading Diagnosis Tests

Frequency Table of Above Correlations, Excluding Totals

.70 to .79	1	.20 to .29	10
.60 " .69	[illegible]	.10 " .19	7
.50 " .59	[illegible]	.00 " .09	[illegible]
.40 " .49	12		49
.30 " .39	6		

Average .37 S.D. ± .167

show that many of the correlations of the letter tests with those memory span tests were not computed because the "finder" device indicated that they would be low. The wide total range, .03 to .79, points to the same probability. Had all or most of the missing correlations in those columns been computed the averages might have been considerably lower.

The average of the correlations of the memory span subtest for letters and the twelve letter tests (Column 3) was .357, not as high as four of the other averages. The range was from .09 to .54. The correlation with phonic combinations was .28, with recognition of capital letters .52, and with small letters .45. Similarity of content seemed to have no particular effect on the size of these correlations.

Table 8 shows thirty-four computed correlations of the memory span subtests with a variety of psycho-physical measures and three correlations of the total memory span test with psycho-physical measures. The averages of all computed by the frequency table was .263; the standard deviation ±.233. The several averages for these tests ran from .127 to .375. Only a few of the coefficients in this table were even fairly high. It seems that slight or no relationships existed between the traits classified in this grouping and the memory span abilities measured.

In Table 9 appear the fourteen correlations of the memory span tests with reversals, and the seven correlations with a total error score. The relationships shown are in terms of fewest reversals and errors compared with longest memory spans. Reversals were of the usual variety common to grade I, including letters, words and digits, and "full" and "partial" reversals. They were divided into two groups, those occurring when the stimulus was visual and those occurring when the stimulus was auditory. Nine tests were used in counting the number of visual,

Table 8

Correlations of Memory Span Tests with Psycho-Physical Measures*

	Van Wagenen Sentences	Gates Diagnosis Tests					
		Digits	Letters	Nonsense Syllables	Fam. Words	Total Col.2-5	Mixed Syllables
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
**G. D. XIII, 3 Writing Time	.36	.40	.40	.42	.40	--	.57
Total Vocabulary Time	--	--	.60	.44	.50	--	.42
Perception	.21	.37	.15	.31	.29	.29	-.08
Steadiness	--	--	.54	.05	.62	--	--
Tapping	--	--	.16	.40	.64	--	--
Perseveration	.05	.32	.29	.15	.04	.17	-.10
Chronological Age	.00	.00	.19	-.23	.14	-.08	.10
Averages	.13	.272	.333	.231	.375	.127	.222

* (See footnote - table 5)
** Gates Reading Diagnosis Tests

Frequency Table of Above Correlations, Excluding Totals

.60 to .69	3	.10 to .19	5
.50 " .59	3	.00 " .09	4
.40 " .49	7	-.00 " -.09	2
.30 " .39	5	-.10 " -.19	1
.20 " .29	3	-.20 " -.29	1
			34

Average = .263 S.D. = ± .233

Table 9

Correlations of Memory Span Tests with Reversals and Total Errors

	Van Wagenen Sentences	Digits	Letters	Nonsense Syllables	Fam. Words	Total Col. 1-5	Mixed Syllables	Ave.
		Gates Diagnosis Tests						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Reversals, Visual	-.04	.30	.22	.18	.25	.26	.10	.18
Reversals, Auditory	.00	.40	-.02	.30	.25	.37	.02	.22
Averages	.02	.35	.10	.24	.25	.315	.14	
Total Errors	.54	.51	.30	.23	.30	.40	.60	.42

Frequency Table of Correlations with Reversals

.40 to .49	1	
.30 " .39	2	Average = .161
.20 " .29	3	S.D. = ± .155
.10 " .19	2	
.00 " .09	2	
-.09 " -.00	2	
	[illegible]	

and five in counting the number of auditory, reversals. The error score was the number of incorrect responses, not including omissions, in six reading tests, fourteen subtests of the Gates Reading Diagnosis Tests, a battery of vocabulary tests, the Hare and Foal test and an original perception test. The correlations of the memory span sub-tests with fewness of errors were moderately high, averaging .42, and ranging from .23 to .60. Those of memory span with reversals were low, averaging .161 with a standard deviation of ±.155.

Most of the reversals counted were made with letters. The correlations of the letter memory span test and reversals averaged .10, indicating no apparent relationship between memory span for letters and ability to write and read letters, numbers, and words without making reversals.

For convenience Table 10 assembles, by types, the average correlations of the various memory span tests with the groupings of mental, reading, letter, psychophysical, reversal and error measures.

Table 10

Averages of Correlations of Memory Span Tests with Groups of Other Measures

	Van Wagenen Sentences	Digits	Letters	Nonsense Syllables	Words	Total Col. 1-5	Mixed Syllables	Average 1-5, 7
			Gates Reading Diagnosis Tests					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mental	.58	[illegible]	.41	[illegible]	.42	.46	.17	.42
Reading	.34	.51	.35	[illegible]	.30	.37	[illegible]	[illegible]
Letters	.4[illegible]	.48	.34	[illegible]	[illegible]	.39	[illegible]	[illegible]
Psycho-physical	.17	.27	[illegible]	.19	.30	.13	[illegible]	[illegible]
Reversals	.02	.35	.10	.24	.25	.32	[illegible]	[illegible]
Errors	.54	.51	.30	.23	.30	.40	.60	.42

CONCLUSIONS

(1) Averages for grade one children showed that statistically the memory span for digits was longer than those for familiar words, nonsense syllables and mixed syllables. After two and one-half years the digit span remained the longest on retests. The span for letters was almost as long as that for digits for grade one children, and for grade three children was reliably longer than the span for nonsense syllables. Possibly memory images of visual forms aided the children in the digits and letter tests. The span for ideas as expressed in sentence form seemed to be about as long as the digit or letter spans for grade one children.

(2) The differences in size of the averages of the correlations of the various types of memory span tests with other tests do not have great statistical significance, since the probable errors of the correlations from which the averages were obtained were relatively high, as shown in Table 2. However, comparison of averages of these correlations by types of test show possible tendencies for the digit, sentence and the mixed syllables memory span tests to be more closely related to mental, reading, and letter tests and to fewness of errors than were letter, nonsense syllable, and familiar word memory span tests. If such tendencies did exist they were probably due to uncontrolled and complicating factors in the test situations rather than to the nature of the materials of the different tests.

(3) It seems clear, also, that memory span ability is not a unitary ability for young children. Perhaps there is a common core or "general" memory span ability, but, if so, it expresses itself with other and varying abilities which results in much variation in the results.

(4) From the preceding conclusions it would seem that experiences and resulting learnings have considerable effect upon memory span abilities, but relatively much less effect than maturation of mental ability with age.

A STUDY OF CHILDREN'S REACTIONS TO FAILURE AND AN EXPERIMENTAL ATTEMPT TO MODIFY THEM[1]

MARY E. KEISTER AND RUTH UPDEGRAFF[2]

Psychologists and educators believe that it is important for an individual to respond adequately in situations involving failure or great difficulty. After his first attempt meets failure, the individual's subsequent, possibly characteristic reaction is related not only to his emotional adjustment but also to his ability to learn and to profit by experience.

It is natural for a young child to be confronted with many situations which are not readily resolved. Moreover, in his attempts to meet and overcome difficulties as they arise lie the child's opportunities to learn. In general, mental hygienists and educators have considered it desirable for a child to attack a difficult problem with composure, to try out one possibility after another in an attempt to reach a solution. It is usually considered that he is not meeting the situation desirably if he retreats from the problem, if he rationalizes, if he leans heavily on an adult for assistance, if he attacks the problem with such emotional accompaniments as crying, sulking, and tantrums.

Even the most casual observation of young children reveals wide differences in such responses. In the face of a difficult situation, some children make attempts at their own solution, intently and without emotion. There are others, however, who under many circumstances, immediately ask for the help of an adult or another child; some retreat from the scene of action when they discover difficulty; some cry or become angry; some rationalize.

Given, then, a variability from child to child (and in some cases the occurrence of modes of behavior which are undesirable from the standpoint of the future as well as of the present), the problem becomes one of discovering the existence of an undesirable pattern and of modifying that pattern if possible. Such was the problem of this study, the purpose of which may be summarized as follows:

1. To devise tests by means of which one may discover what responses a child of preschool age gives when faced with failure.
2. To select a group of children evidencing undesirable modes of response.
3. To attempt to modify, by special help or individual training, the responses of the children in this group.

Mental hygienists have employed the concept of failure in two ways. They have used it in connection with a situation which is ultimately impossible for the individual to overcome because of his own incapacity; under such circumstances it is important for him to realize this fact and adjust himself to the idea of the impossibility. In the second sense, failure has been thought of as a step in the

[1] A more detailed account of this study may be found in Updegraff, Ruth, Keister, Mary Elizabeth, Heiliger, Louise and others: Studies in Preschool Education I. Univ. Iowa Stud., Stud. in Child Welfare, 1937, 14, No. 4. (In press)

[2] From Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

CHILD DEVELOPMENT, Vol. 8, No. 3 (September, 1937)

process of solving a problem, as involved in the individual's working his way out of a difficulty. It is with behavior of the latter type that this study is concerned. Failure, as defined here, is the child's lack of immediate success following an attempt to contend with a situation, the situation being one in which he sees some relation to himself as an instrument of his own success or failure.

A preliminary survey of suitable approaches indicated the inapplicability of the observational method, at least in the beginning stages of the study. Not only did it become apparent that failure situations occurred in the nursery school with such infrequency that the time-sampling method was too extensive, but also controls of motivation and of the difficulty of the tasks were lacking. Accordingly, plans were made for presenting failure in experimental situations. The decision was made to confront the child with one situation somewhat in the form of a puzzle, with another which challenged his physical strength, and with a third which offered social obstacles. Among the criteria for setting up the experiments were the following:

1. They must be possible of accomplishment and yet of such difficulty that the child does not succeed immediately.
2. They must provide situations which are natural, in the sense that the difficulties are not obviously or forcibly imposed.
3. The average child should be able to see for himself that he has failed and to see in the situation some relation to himself as an instrument of his success or failure.

As a result of preliminary study, two test situations were believed adequate for use. The first, the puzzle box test, confronted the subject with a small, lidded, colored box, 9 by 7 by 1 1/2 inches. The box being opened, it was found to have a false bottom within 1/4 inch from the top. On this lay ten small, colored figures, of irregular shape, 1/4 inch thick, representing various objects of interest to children, such as a sailboat and an engine. Because of their form they fitted rather closely into the available space. The experimenter then removed the figures and gave the test instructions which invited the child to put the blocks into the box so that the lid could go down again. In spite of the fact that there were several ways in which the blocks could be fitted into the space, the task was quite a difficult one to complete in the fifteen minutes allowed. There was no question of its being an interesting one to children.

The weighted box test consisted of a five-sided box, weighted at the ends and through the middle with from 60 to 90 pounds of iron weights. These weights were adjustable. The box was placed in the middle of a room upside down over a group of attractive toys. When the subject entered, the box was raised slightly, then lowered. Instructions indicated that the toys could be played with if the box could be lifted in order to obtain them. Ten minutes was the time allowed.

The same scheme for recording behavior, a system of controlled observation with time divisions of minutes, was used for both tests. The type of behavior observed is indicated in the tables.

The subjects in this study, 82 children (38 boys and 44 girls) aged three to six years, were enrolled in the preschool laboratories of the Iowa Child Welfare Research Station. The mean intelligence quotient was 122. Because the tests evidenced no statistically significant age differences, marked individual differences being apparent at all ages, the data have not been classified into age

groups. Comparative frequency of various types of responses in the two tests are indicated in Tables 1 and 2. In each test the most frequent response of the group as a whole was "attempts to solve alone" although "interest" ran a close second. That requests for either partial or complete help and rationalizations were more common than disgruntled emotional responses proved to be the case.

Inasmuch as it was the purpose of these tests to differentiate between those subjects giving undesirable or immature responses and those responding more desirably, the extent to which this end was achieved was first to be determined. To describe the process briefly, certain objective criteria were set up in terms of test behavior. Five kinds of behavior occurring for at least a minimum amount

Table 1

Mean Number of Minutes During Which Responses Occurred During Puzzle Box Test (N = 81)*

Behavior	Mean	Standard Deviation
No overt attempt	2.2	3.2
Attempts to solve alone	11.1	4.2
Asks another to solve	1.2	2.3
Asks help	1.5	2.1
Destructive behavior	.1	.5
Rationalizes	1.2	1.8
Interest	10.2	4.7
No emotional manifestations	1.6	2.9
Indifference	.2	1.4
Smiles	.2	.9
Laughs	.1	.2
Sulks	.2	.6
Cries	.3	1.2
Whines	.8	2.0
Yells	.1	.4
Motor manifestations of anger	.04	.3

*Mean length of experimental period: 13.3 minutes.

Table 2

Mean Number of Minutes During Which Responses Occurred During Weighted Box Test (N = 74)*

Behavior	Mean	Standard Deviation
No overt attempt	3.4	2.8
Attempts to solve alone	5.7	2.7
Asks another to solve	.4	3.6
Asks help	1.1	1.9
Rationalizes	1.0	1.5
Interest	5.7	3.2
No emotional manifestations	2.1	2.6
Indifference	.1	.9
Smiles	.3	.8
Laughs	.1	.4
Sulks	.2	1.0
Cries	.3	.9
Whines	.7	1.7

*Mean length of experimental period: 9.1 minutes.

of time were listed and definitely stated quantitatively. If a child's behavior fell into two or more of these classifications on either or both tests, he was judged to have given an immature response. In brief, these five types were as

follows: (1) giving up attempts to solve the puzzle box in less than five minutes or to solve the weighted box in less than two minutes, (2) requesting help during more than one-half the total time of the test, (3) manifesting destructive behavior, (4) making more than two rationalizations, (5) evidencing exaggerated emotional responses.

Analysis of the test records showed a total of fifteen children (16 per cent) who fell into the immature group.

The diagnostic value of the tests is illustrated by contrasting frequencies of behavior as shown in Tables 3 and 4, in which it is apparent that real differences do exist between the groups as classified by this means.

The next step in the study was the training program. In this, twelve out of the fifteen children participated.

Table 3

Mean and Standard Deviation of Responses in Minutes for Two Groups of Subjects on Puzzle Box Test

Behavior	Group Showing Undesirable Or Immature Response (N = 15)		Remainder of Total Group (N = 84)	
	Mean	Standard Deviation	Mean	Standard Deviation
No overt attempt	6.0	3.7	1.6	2.3
Attempts to solve alone	8.5	4.2	13.0	3.0
Asks another to solve	3.6	3.4	.8	1.6
Asks help	2.5	2.4	1.5	2.1
Destructive behavior	.6	1.1		
Rationalizes	2.8	2.5	1.0	1.4
Interest	6.0	3.8	12.4	3.9
No emotional manifestations	2.5	2.4	1.7	3.2
Sulks	.8	1.3		
Cries	1.7	2.4		
Whines	2.6	2.9	.5	1.5
Yells	.3	.8		
Motor manifestations of anger	.2	.5		

Table 4

Mean and Standard Deviation of Responses in Minutes for Two Groups of Subjects on Weighted Box Test

Behavior	Group Showing Undesirable Or Immature Response (N = 15)		Remainder of Total Group (N = 50)	
	Mean	Standard Deviation	Mean	Standard Deviation
No overt attempt	5.2	2.9	3.4	2.4
Attempts to solve alone	4.2	2.8	6.5	2.3
Asks another to solve	.7	1.6	.3	.9
Asks help	2.2	2.3	.9	1.7
Rationalizes	1.7	1.2	.8	1.5
Interest	3.5	3.0	6.8	2.9
Sulks	1.0	2.0		
Cries	1.0	1.6	.1	.4
Whines	2.3	2.3	.3	1.2

The basic philosophy underlying the training assumed that children can learn to meet difficulty in a controlled manner and acceptably if they know from experience what type of behavior is most likely to bring success or satisfaction. It was the aim of the training program to raise the responses of the immature

group nearer to the level of desirability. Specifically, in the training an attempt was made to teach the child to persist longer in the face of difficult tasks (which were, however, not impossible ones), to teach him to depend less upon an adult for help, and to attack a problem and see it through with some composure.

The method of training consisted in introducing the child to a series of problems which grew progressively more difficult as the program of training proceeded. The problem situations reflected the following criteria:

1. The tasks should be graded in difficulty so that the child experiences success in the earlier ones and gradually works up to problems which are difficult for him.

2. The later tasks must be of such difficulty that the child does not succeed immediately but is forced to persevere, to continue to try if he is to attain success.

3. The child must be able to see his progress and previous successes.

In describing the two training situations briefly[1] it may be said that they were similar in type but differed in the specific materials used. For the first, four picture-puzzle books were prepared, each one in the series more difficult than the one preceding and each one of graduated difficulty from beginning to end. For these, interesting, colorful and appropriate story books were cut up. The pictures were mounted on 4-ply wood, varnished, cut into puzzles, and the book was rebound on loose rings. The experimenter read the story to the child. As she reached a part illustrated by one of the pictures, she stopped for him to put the puzzle together before continuing the story. After the first picture was completed she covered it with cellophane, so that both she and the child could refer to it later, and resumed the story until the next picture. Each book contained four to six pictures.

In the second situation a "block boy" was built. Copied from a drawn pattern hung on the wall, he was to be made of colored blocks placed upon each other so that having attained first feet, then legs, then trunk and arms, then head, he stood approximately three feet high, a somewhat precarious figure and a frequently exasperatingly unsteady one. Usually several attempts were necessary in order to complete him. After a successful production his builder had the task of devising a hat from a wide variety of materials provided.

The entire program of training was handled by one person. Training periods varied in length from eight to thirty-three minutes, depending largely upon the difficulty of the tasks and the child's behavior. To subject the twelve children to all of the training took approximately six weeks.

Behavior during the training program underwent a gradual improvement as is shown by both objective and subjective estimate. In order to study post-training behavior objectively, two approaches were utilized; first, retests by means of a similar but not identical puzzle box were given the trained subjects (see Figure 1); second, also retested were an equal number of children, not in the trained group, who during the initial tests had shown some undesirable behavior (see Figure 2).

[1] Detailed descriptions of all the materials used in this study may be obtained from the Iowa Child Welfare Research Station, Iowa City, Iowa.

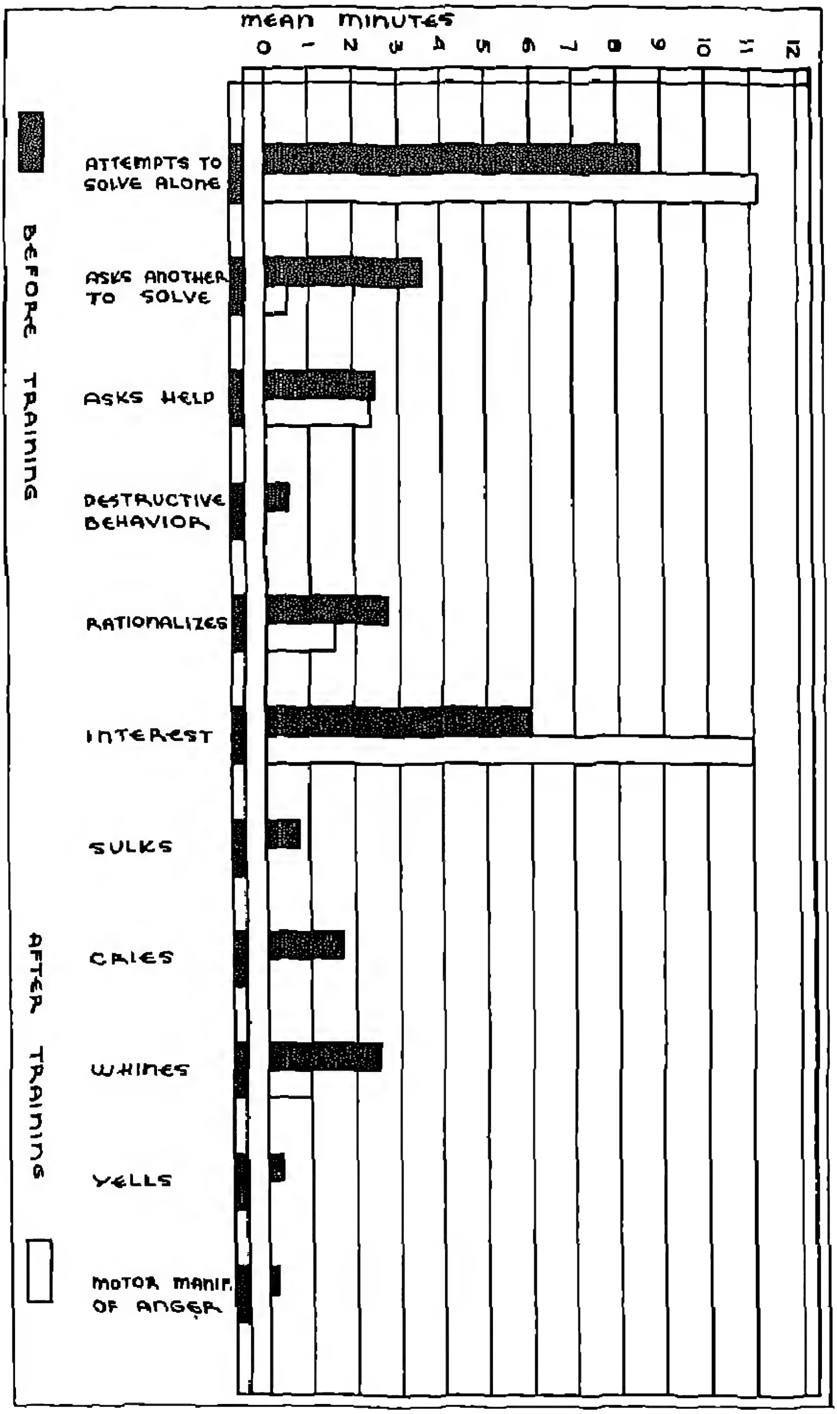

Figure 1. Responses of Trained Group on Puzzle Box Test Before and After Training.

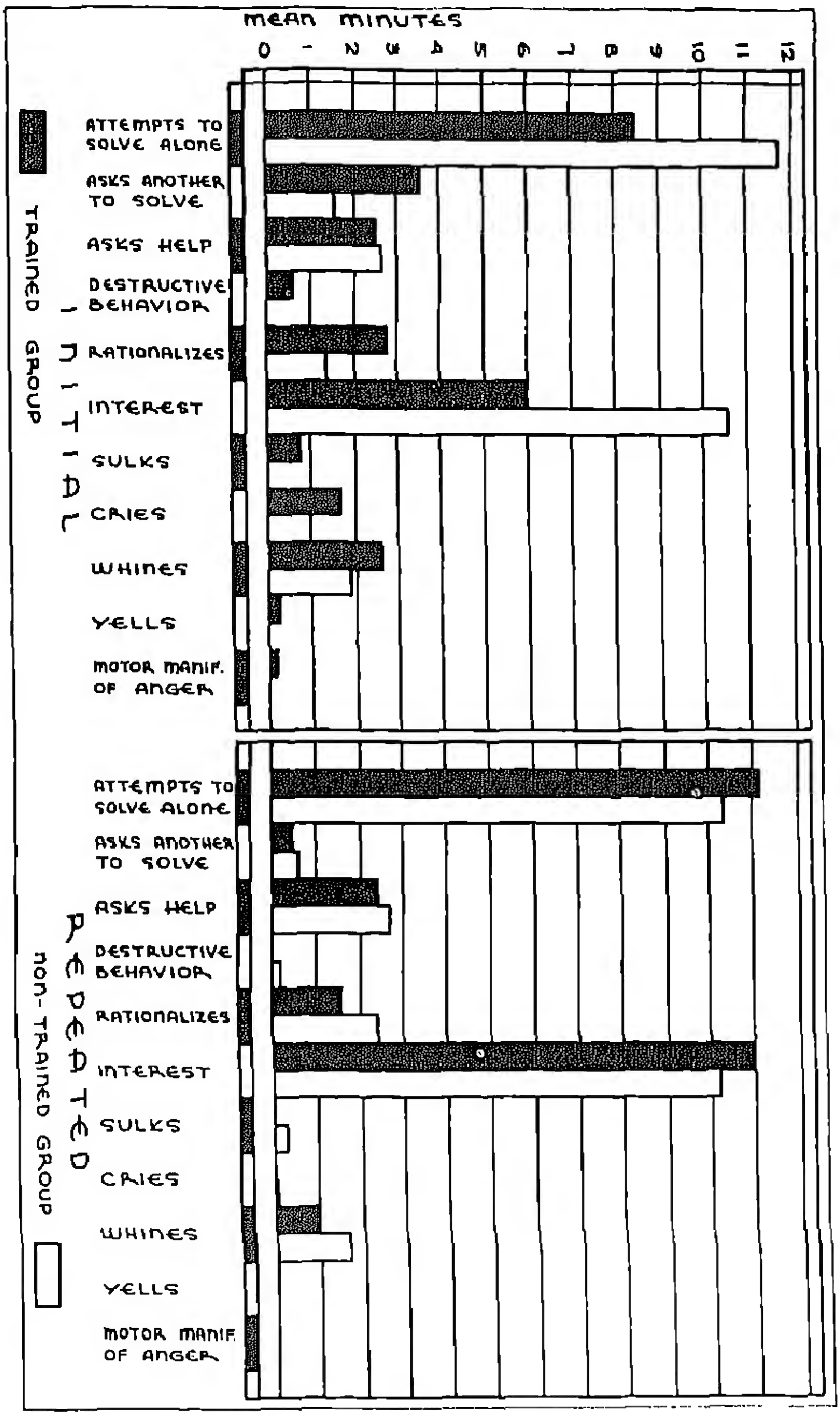

Figure 2. Response of Trained and Untrained Groups on Puzzle Box Test.

It is evident from a study of Figure 1 that the behavior of the children after training was remarkably different from their behavior prior to training. Differences in the three items attempts to solve alone, interest, and cries are statistically significant. Excepting in the case of the item asks help, the remaining differences closely approximate significance. The differences were in form of the responses given in the retest and indicate that a reasonable improvement was effected in the trained group. The exaggerated emotional responses of sulking and crying dropped out entirely in this group.

Figure 2 concerns responses of the trained and the compared nontrained group before and after training. The two groups differed in the responses no overt attempt, attempts to solve alone, interest, sulks, and cries. All of the differences were in favor of the trained subjects in spite of the fact that previous to training the difference lay in the opposite direction.

The results of this study, hopeful as they are, must be interpreted in the light of the specific conditions. The entire program was carried out by the experimenter, who also gave the retests. Further study, at present underway, must determine the extent to which the more desirable behavior occurs in other situations and with other persons. There is evidence that behavior of children in difficulties has been similar in two test situations; it would be valuable to make observations in other situations and under circumstances of a more social nature. Probably the most important contribution of the present study is its indication of the marked effect of this training program. After training, children tried longer, manifested more interest in solving problems themselves, and completely eliminated emotional behavior. Evidently this improvement was not a function of age or other training. Of particular interest to teachers and psychologists may be the fact that the program of training was neither arduous nor time-consuming.

THE OBJECTIVITY OF ANTHROPOMETRIC MEASUREMENTS TAKEN ON EIGHT- AND NINE-YEAR-OLD WHITE MALES

EVERETT L. MARSHALL[1]

PURPOSE

This study has been developed in such a manner as to constitute a companion paper to one recently completed (2). The earlier paper dealt with the reliability of anthropometric measurements - reliability being determined by the differences between initial and repeated observations made by a single anthropometrist. The present study pertains to the objectivity of anthropometric measurements - objectivity being considered as a function of like differences when the initial measurements are made by one anthropometrist and repeated observations are taken by a second anthropometrist.

It follows, then, that the purpose of this study is in part investigative and in part comparative. On the one hand it attempts to investigate the objectivity of a series of physical measurements made on boys eight and nine years of age, and on the other hand it affords a comparison of the resulting objectivity findings with earlier findings for reliability (2). Specific major aims are: (1) To determine to what extent, if at all, one investigator tends to secure smaller or larger measurements than the other for any given dimension. In question form this aim becomes: Are there systematic differences in the measurement technique of the two anthropometrists? (2) To obtain for each of the fifteen anthropometric dimensions objectivity tables. These tables are to be derived from measurement observations taken under relatively optimum conditions. (3) To relate each objectivity table to the rate of growth for the dimension from which it is derived and to compare the resulting "frequency of consecutive measurement" estimates with those obtained for reliability (2).

MEASUREMENTS[2]

The fifteen anthropometric dimensions selected for study are itemized below. Each item is complemented by a descriptive statement of the measurement technique employed in determining the dimension.

<u>Stature</u>: The instruments used were the Baldwin Paper Measuring Scale and Square. The subject stood erect with heels almost touching each other. Heels, buttock, upper part of back, and rear of head were against the wall to which the scale was attached. The arms were permitted to hang at the sides of the body in a natural position, the heels were in firm contact with the floor, and the head was held on the Frankfort Horizontal. One face of the square was so placed against the scale that the other face was horizontal with the floor. The anthropometrist then brought down the square with sufficient force to crush the subject's hair and made the reading.

<u>Sitting Height</u>: The instruments were the same as for stature. The subject sat on a horizontal walnut bench 30 centimeters in height. His knees were flexed and spread apart, his ankles crossed, and his hands rested on his thighs. The posterior aspect of the trunk made contact with the scale both at the sacral region and at the thoracic

[1] From Illinois State Normal University, Normal, Illinois.

[2] The measurement technique described here is supplied verbatim by Dr. Howard V. Meredith. (2)

region. The square was brought down firmly on the vertex (the highest point of the head when held on the Frankfort Horizontal) and the measurement recorded as the distance from this point to the surface of the bench.

Bi-acromial Diameter: Standardized large sliding calipers having broad flat branches were used in taking this measurement. The subject assumed the erect position with his arms hanging at his sides. In an attempt to standardize this diameter as much as possible, the anthropometrist stood behind the subject and drew back the subject's shoulders until the bodies of the two scapulae lay approximately in one plane. The measurement was determined as the distance between the most lateral points of the acromial eminences.

Bi-iliac Diameter: This measurement was taken as the straight distance between the most lateral points of the crests of the ilia. The instrument used was the same as for the previous dimension. The observer stood in front of the subject, brought the face of each branch of the calipers squarely in contact with the landmark, and applied the maximum pressure that could be exerted without pain to the subject. In the event that the subject appeared to turn his trunk and hips at the time the pressure was applied, the measurement was checked.

Bi-trochanteric Diameter: The subject stood erect with legs together and feet parallel. The most external prominences of the greater trochanters were the terminal measurement points. Pressure was applied to the large sliding calipers until considerable resistance of the bones was felt.

Bi-condylar Diameter of Humerus: This measurement was taken on the upper left extremity by means of the large sliding calipers. The left arm of the subject was raised forward to approximately the level of the shoulder and the forearm flexed upward at right angles to the arm. The branches of the calipers were then applied against the epicondyles of the humerus in such a manner as to bisect the angle of the elbow and lie in the plane of the arm and forearm. Heavy pressure was used, care being taken that the forearm did not move out of line with the branches of the calipers and tip in toward the midline of the body.

Bi-condylar Diameter of Femur: Here the large sliding calipers were used and the maximum straight distance obtained between the condyles of the left femur. The knee of the subject was flexed sufficiently to relax and largely remove the musculature at the lateral aspects of the condyles. The branches of the calipers bisected the thigh-leg angle as they were brought in contact with the bony prominences. Considerable pressure was used. The anthropometrist stood in front of the subject while taking this measurement.

Circumference of Thorax: A steel millimeter tape was used to determine this measurement. The subject stood in a natural manner with head erect and with arms relaxed and held slightly away from the sides of the body in order to permit the passing of the tape around the thorax. The observer stood in front of the subject and, using the xiphoid cartilage of the sternum as the anterior landmark, placed the tape around the thorax at right angles to the spinal column. Posteriorly, the tape always rested below the inferior angles of the scapulae. The tension applied was only sufficient to insure complete contact with the skin. Record was made of the median value during the normal respiration.

Circumference of Arm: The instrument employed in securing this and the three succeeding limb girths was the steel millimeter tape. As with thoracic circumference, the tape was applied to make contact all around and yet avoid compression of the tissues. All observations were taken on the left extremities of the body.

Arm circumference was measured near the middle of the humerus, at the level of the greatest girth over the biceps muscle and below the insertion of the deltoid muscle. The plane of the tape was at right angles to the line of the humerus. During measurement the subject assumed the erect position with the upper extremities hanging near the sides of the body (slightly abducted) in a relaxed condition.

Circumference of Forearm: The position of the limb was the same as for the previous measurement, and identical technique was used except that the observation was taken at the level of the greatest girth below the elbow joint and in the region of the radiale. Care was taken to see that the musculature of the forearm and hand was relaxed.

Circumference of Thigh: The subject stood with his feet spread about 9 inches apart and his weight equally distributed on both lower extremities. The tape was passed around the thigh at right angles to its long axis and the measurement made at a level just below the gluteal sulcus.

Circumference of Leg: The subject maintained his position as for the previous measurement and the maximum girth of the calf at right angles to its long axis was determined.

Thickness of Skin and Subcutaneous Tissue at Thorax Back: This measurement, together with the two measurements which remain to be described, was taken with so-called "fat" calipers devised by the American Child Health Association. In all three instances the flat, blunt-nosed branches of the calipers were held parallel to the long axis of the body or extremity of the subject.

In taking the measurement at the rear of the thorax, the anthropometrist placed the thumb and first finger of his left hand about 40 millimeters apart over the region below and slightly lateral to the inferior angle of the left scapula and in the transverse plane

of the xiphoid cartilage. He then moved these digits directly toward each other, taking care that they did not tend away from the thorax. The instrument was next applied to the tissue held between his thumb and finger and the measurement read off. The objective was to measure the thickness of a complete double layer of skin and subcutaneous tissue without including any muscle tissue.

<u>Thickness of Skin and Subcutaneous Tissue at Arm Back:</u> This measurement was taken over the triceps muscle at approximately the mid-point of the shaft of the left humerus with the arm hanging in a relaxed condition. The technique was the same as for the previous measurement.

<u>Thickness of Skin and Subcutaneous Tissue above Iliac Crest:</u> The calipers were applied immediately superior to the crest of the left ilium in a line vertical with the left axilla. The size of the bite taken between the digits of the anthropometrist varied with the amount of subcutaneous tissue of the individual subject.

All measurements were made on the nude subject and recorded to the nearest millimeter.

SUBJECTS

The subjects for this study were twenty-five Iowa City boys enrolled in the third and fourth grades of the University of Iowa elementary school during the year 1935-1936. Each boy was scheduled to serve as a subject for the study six consecutive times, once every four weeks beginning November 13 or 14 and ending April 1 or 2. Occasional absences, however, reduced the total number of examinations to 141. The youngest boy in the group was seven years, eight months at the time the first examination was made, and the oldest boy was ten years, two months by the time of the final examination.

The principal reason for accumulating the data on twenty-five individuals rather than on 141 different individuals lay in the fact that this smaller group was already under observation in connection with a seriatim growth study.

> "In addition to being conveniently available, however, the sample was found to represent considerable dispersion in body size and build. The eight-year-old boys ranged between 128.0 cm. and 143.9 cm. for stature, between 57.2 cm. and 66.6 cm. for thoracic circumference, and between 33.4 cm. and 43.5 cm. for girth of thigh. The shortest boy had the largest thigh circumference and the tallest boy the second smallest girth of thorax. Similar deviation characterized the nine-year-olds. Stature ranged from 132.6 cm. to 152.7 cm., bi-iliac diameter from 19.9 cm. to 24.1 cm., and arm girth from 17.4 cm. to 23.1 cm. The tallest boy had the largest bi-iliac diameter while the shortest had the largest circumference of arm." (2)

EXAMINATION PROCEDURE

The following procedure was employed at each examination:

1. The subject removed all clothing.
2. The first anthropometrist made observations for each of the fifteen measurements being investigated and serially called off each observed value to a recorder.
3. As the first anthropometrist left the room, the second one entered and made observations for the same fifteen physical dimensions.

Two investigators, Dr. Howard V. Meredith and the writer, made all the measurements employed in this study. The recording was done by Dr. Newell C. Kephart.

Extreme care was exercised at all times to measure as accurately as possible and to avoid errors in recording.

CONSISTENT DIFFERENCES

The data consist of 141 pairs of observations for each of fifteen anthropometric dimensions, each pair of which is composed of two successive measurements made by two anthropometrists. To check for any tendency on the part of either investigator consistently to secure smaller or larger measurements for any given dimension than those secured by the other investigator, the following procedure was employed. Considering the measurement secured by one investigator (the writer) throughout as the starting point, the difference between the measurement secured by the first investigator and that secured by the second was marked positive if the latter measurement was larger and negative if it was smaller. Next the mean of the positive differences and the mean of the negative differences were found for each dimension. The difference between these means was then computed; the results are shown in the final column of Table 1. In ten of the fifteen measurements, the mean difference in a positive or negative direction was less than 1 millimeter. Three of the mean directional differences were between 1 and 2 millimeters and two were exactly 2 millimeters. For every dimension having a positive "mean difference" (see Table 1) the positive differences were found to exceed, in number, the negative differences, and for every dimension having a negative "mean difference," there were a greater number of negative than positive differences. This indicates that the mean directional differences are representative and are not the function of a few extreme differences. The second investigator (the writer) secured measurements for height and sitting height which were on the average 1.5 millimeters larger than those secured by the first investigator. For dimensions of thoracic circumference, thigh girth, and arm girth the opposite was true - on the average the measurements secured for the first two dimensions by the second investigator were 2 millimeters smaller and for arm girth 1 millimeter smaller. From Table 1

Table 1

Mean Differences Between the Measurements Secured by the Two Investigators Who Made 141 Pairs of Observations for Each of Fifteen Dimensions

Dimension	Positive Differences	Negative Differences	Zero Differences	Mean Differences (mm.)
Stature	83	45	13	+1.4
Sitting height	85	45	11	+1.7
Thoracic circumference	54	81	6	-2.0
Bi-acromial diameter	67	69	5	- .5
Bi-iliac diameter	43	58	40	- .2
Bi-trochanteric diameter	50	65	26	- .7
Bi-condylar diameter of humerus	33	66	42	- .3
Bi-condylar diameter of femur	33	54	54	- .3
Girth of arm	41	80	20	-1.1
Forearm girth	53	52	26	+ .1
Thigh girth	46	89	6	-2.0
Girth of leg	65	50	26	+ .3
Thickness of skin and subcutaneous tissue:				
At arm back	23	63	55	- .5
At thorax back	9	47	85	- .3
Above iliac crest	22	73	46	- .7

it appears that the directional differences are so small that for practical purposes they may be considered negligible.

OBJECTIVITY FINDINGS

The objectivity constants shown in Table 2 were found by computing the differences, irrespective of sign, between the two component measurements comprising each of the 141 pairs of observations. The median, ninetieth percentile, and maximum difference for each of fifteen dimensions were derived from frequency distributions of these differences. Some of the results shown in this table are:

1. The thickness of skin and subcutaneous tissue on the back of the thorax was measured with the least absolute error. The greatest absolute difference was encountered in measurements for stature, sitting height, and bi-acromial diameter.

2. Measurements with objectivity approximating that of thickness of skin and subcutaneous tissue on the back of the thorax were bi-iliac diameter, bi-condylar diameter of humerus, bi-condylar diameter of femur, and the other two measurements of skin and subcutaneous tissue.

3. Bi-iliac diameter was measured more accurately than bi-trochanteric diameter.

4. The measurements of leg girth and forearm girth (soft tissue dimensions) were secured with less absolute error than bi-trochanteric diameter (a bony dimension).

5. Forearm girth and leg girth were measured with more consistency than thigh girth and arm girth.

Additional findings were secured (1) by calculating the coefficient of objectivity by the Pearson product-moment method of correlation, and (2) by expressing the median and maximum values in Table 2 in relation to the actual size of the dimension from which each was derived. Means for the various dimensions for nine-year-old boys were secured from studies by Meredith (1) and by Meredith and Boynton (3).

From Table 3 it is noted:

1. The objectivity medians in Table 2, when referred to the mean magnitude of their respective dimensions, equal one-half of 1 per cent or less for stature, sitting height, bi-iliac diameter, thoracic circumference, and leg girth; less than 1 per cent for bi-trochanteric diameter, forearm girth, bi-condylar diameter of the femur, and arm girth; less than 2 per cent for thigh girth, bi-acromial diameter, and bi-condylar diameter of the humerus; and from 4 to 9 per cent for the three measurements of skin and subcutaneous tissue.

2. The maximum measurement differences given in Table 2 range from approximately 1 per cent of the mean size of their corresponding dimensions to 60 per cent. Stature has the lowest percentage; the other dimensions, excepting those of skin and subcutaneous tissue whose percentages are 24 or greater, have percentages ranging from 1 to 9.

3. The coefficients of objectivity range from .80 to 1.00, stature having the highest and bi-acromial diameter having the lowest.

OBJECTIVITY FINDINGS IN RELATION TO RATE OF GROWTH

The relationship between objectivity findings and rate of growth was determined by proceeding on the assumption used by Meredith (2) in relating findings for

Table 2

Objectivity Constants for Fifteen Anthropometric Dimensions: Each Series of Constants Was Derived from Values Representing the Difference Between Two Measurements Taken Successively by Two Anthropometrists on the Same Subject

Difference Interval (mm.)	Stature		Sitting Height		Thoracic Circumference		Bi-acromial Diameter	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
0 to 1	38	27.0	33	23.4	35	24.8	40	28.5
2 to 5	58	41.1	73	51.8	60	42.6	57	40.4
6 to 10	36	25.5	22	15.6	31	22.0	24	17.0
11 to 15	7	5.0	10	7.1	10	7.1	15	10.6
16 to 25	2	1.4	3	2.1	5	3.5	5	3.5
	141	100.0	141	100.0	141	100.0	141	100.0
Median	3.6		3.1		2.8		3.0	
90th Percentile	9.2		9.5		11.0		12.5	
Maximum	19.		20.		24.		24.	

Difference Interval (mm.)	Arm Girth		Forearm Girth		Thigh Girth		Leg Girth	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
0 to 1	59	41.9	80	56.7	26	18.5	74	52.5
2 to 5	70	49.6	54	38.3	66	46.8	64	45.4
6 to 10	11	7.8	7	5.0	37	26.2	3	2.1
11 to 15	1	.7			12	8.5		
	141	100.0	141	100.0	141	100.0	141	100.0
Median	1.9		1.3		4.0		1.4	
90th Percentile	5.3		4.1		9.5		4.2	
Maximum	15.		9.		17.		8.	

Difference Interval (mm.)	Bi-trochanteric Diameter		Bi-iliac Diameter		Breadth of Elbow		Breadth of Knee	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
0	26	18.4	40	28.3	42	29.7	54	38.3
1	44	31.2	72	51.1	72	51.1	68	48.2
2	27	19.1	19	13.5	19	13.5	14	9.9
3	18	12.8	8	5.7	8	5.7	3	2.1
4 and 5	16	11.3	2	1.4			2	1.4
6 to 10	10	7.1						
	141	99.9	141	100.0	141	100.0	141	99.9
Median	1.5		.9		.9		.8	
90th Percentile	5.1		2.3		2.2		1.8	
Maximum	10.		4.		3.		5.	

Thickness of Skin and Subcutaneous Tissue:

Difference Interval* (mm.)	At Arm Back		At Thorax Back		Above Iliac Crest	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
0	55	39.0	85	60.3	46	32.6
1	59	41.8	50	35.5	56	39.7
2	22	15.6	6	4.2	20	14.2
3	5	3.5			11	7.8
4 to 6					8	5.7
	141	99.9	141	100.0	141	100.0
Median	.8		.4		.9	
90th Percentile	2.1		1.3		3.0	
Maximum	3.		2.		6.	

*This series of differences is for the actual measurement of a double layer of tissue. One-half the values given afford an estimate of the errors of measurement for a single layer.

Table 3

Objectivity Findings Supplementary to Those Given in Table 2

Dimension	Median from Table 2 x 100 / Mean Size of Dimension	Maximum from Table 2 x 100 / Mean Size of Dimension	Objectivity Coefficient
Stature	.26	1.39	1.00
Bi-iliac diameter	.42	1.87	.98
Sitting height	.43	2.76	.97
Thoracic circumference	.44	3.73	.97
Girth of leg	.52	2.98	.97
Bi-trochanteric diameter	.63	4.22	.96
Forearm girth	.67	4.67	.96
Bi-condylar diameter of femur	.95	5.97	.93
Girth of arm	.99	7.78	.97
Thigh girth	1.01	4.31	.97
Bi-acromial diameter	1.03	8.22	.80
Bi-condylar diameter of humerus	1.63	5.42	.87
Thickness of skin and subcutaneous tissue:			
At thorax back	4.80	24.39	.93
At arm back	6.25	23.44	.93
Above iliac crest	9.00	60.00	.84

reliability to the rate of growth, namely, that seriatim observations are profitably made only when the interval between them is large enough to allow a mean increment of growth which equals or exceeds 90 per cent of the reliability differences. The reliability differences here become objectivity differences, but otherwise the procedure is similar.

Table 4 shows the findings on relationship for eight- and nine-year-old boys. Given successively in the first three columns are (1) the series of dimensions under consideration, (2) the annual rate of mean growth in each dimension, and (3) the ninetieth percentiles of objectivity distributions for each dimension. The time frequency at which it appears practical to make seriatim observations for the purpose of studying the growth of the individual appears in column four.

Table 4

Relationship Between Anthropometric Objectivity Constants and Growth Increments for Eight- and Nine-Year-Old Boys

Dimension	Mean Annual Increments (mm.)	Objectivity Criterion (mm.)	Estimated Maximum Frequency of Measurements
Stature	54	9.2	Bimonthly (?)
Bi-iliac diameter	8	2.3	Quarterly (?)
Girth of leg	10	4.2	Semiannually
Bi-trochanteric diameter	10	5.1	Semiannually
Sitting height	21	9.5	Semiannually
Thoracic circumference	22	11.0	Semiannually
Girth of thigh	18	9.5	Semiannually (?)
Forearm girth	6	4.1	Annually
Arm girth	7	5.3	Annually
Bi-condylar diameter of femur	2	1.0	Annually
Bi-acromial diameter	10	12.5	Annually
Bi-condylar diameter of humerus	1	2.2	Biannually

*This column of values was taken from Meredith (2)

SUMMARY AND CONCLUSIONS

Objectivity findings - objectivity being considered as a function of the differences when initial observations are made by one anthropometrist and repeated measurements are taken by a second anthropometrist - are presented for each of fifteen anthropometric dimensions taken on eight- and nine-year-old boys.

Preliminary computation of the mean directional differences yield results which indicate that systematic differences in measurement technique of the two anthropometrists for each of the fifteen dimensions are of negligible importance.

Objectivity tables derived from pairs of measurement observations taken under unusually favorable conditions are presented. Some of the findings are: the most objective dimension is the thickness of skin and subcutaneous tissue on the back of the thorax; the least objective measurements are stature, sitting height, and bi-acromial diameter.

The objectivity constants, chosen to represent given body dimensions, are referred to the annual rate of growth for the dimension from which they were derived. From this procedure, estimates of the practical time interval to allow between seriatim measurements of various dimensions are made. Some dimensions are found to be taken advantageously quarterly or semiannually while for others it appears that no significant contributions to individual growth trends are made by taking measurements oftener than annually or biannually. By comparing results with those for reliability (2), it appears that changing anthropometrists from one observation period to another increased the size of the time interval for four of the dimensions, but for the remaining dimensions the interval between observations remained the same regardless of the change in anthropometrists. From the results of these two studies it appears obvious that not all measurements should be taken at each examination period of a seriatim measurement program.

Finally, objectivity for the fifteen measurement dimensions studied, for boys eight and nine years of age, compares favorably with reliability. The findings also lend additional evidence to substantiate the conclusions made by Meredith (2) that "efficient and economical research on the physical growth of the individual lies (1) in a differential approach to anthropometric dimensions and (2) in employment of unusually rigorous measurement technique."

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PERSONALITY CHARACTERISTICS OF JUVENILE DELINQUENTS
II. RELIABILITY OF DIFFERENTIATING TRAITS

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INTRODUCTION

The first section (3) of this investigation dealt with a method whereby items were selected from each of four tests of the Pressey Interest-Attitude Tests which best differentiate delinquents from non-delinquents. As a basis for selecting items three criteria were established. The operation of these was illustrated and the consistency of the method demonstrated. By employing the procedure described there emerged from each test a list of items which appeared to be maximally effective in distinguishing between the control and experimental groups under consideration. Seven differentiating items from Test I (things considered wrong) were found; five from Test II (worries, fears, anxieties); six from Test III (likes and interests); and eight from Test IV (kinds of people liked or admired).

While the consistency of the differentiating items seems to be assured by the analysis performed in the first section, it is the object of the second section to examine further their reliability and diagnostic significance.

PROBLEM AND METHOD

To make clear the procedure followed differential items from each test are listed below:

Test I (things considered wrong). carrying a revolver (+), gang (+), being conceited (-), being a snob (-), playing cards (+), bribery (-), prison (+).

Test II (anxieties, fears, worries). jail (+), family (+), death (+), dying (+), sins (+).

Test III (likes and interests). church (+), circus (+), movie star (+), tap dancing (+), joyriding (+), candy (+).

Test IV (kinds of people liked or admired). handsome (+), husky (+), quick (+), well-dressed (+), wealthy (+), good-looking (+), cooperative (-), rich (+).

It will be noted that after each item a plus or minus sign is shown. In general these signs indicate the direction of original responses. That is, when delinquents responded proportionately a larger number of times than non-delinquents to a given item it was denoted with a plus sign. The converse received a minus designation. Only in Tests I and IV do items occur with minus denotations. Operation of plus and minus signs will be clarified subsequently.

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CHILD DEVELOPMENT, Vol. 8, No. 3 (September, 1937)

For purposes of determining the reliability of the differential items, the following course has been adopted:

(a) Interest-Attitude Tests constituting each life age grouping of delinquents were re-scored in terms exclusively of the differential items from each test. Subjects were the same groups, 14, 15, 16, and 17-year, that were used in the statistical analysis of section one, similar life age groupings being retained in the present section.

(b) Each life age group of delinquent boys was paired with a control group of non-delinquent boys of the same life age. Responses of the control groups on each of the Interest-Attitude Tests were likewise differentially scored.

(c) Besides the original groups of subjects the technique of differential scoring was applied to an entirely new sample of 115 delinquent boys of mixed life age, the median being 16.6 years.

(d) Although the analysis in section one which resulted in the selection of differential items was confined to life age groupings 14 to 17 years inclusive, it was considered of interest to ascertain the significance of the items for a younger life age group. Hence, a control and experimental group of 13-year subjects have been included in the present analysis.

In each of the four Interest-Attitude Tests the subject is directed to single-cross (X) or double-cross (XX) items depending on the extent and intensity of reaction to them. Thus in deriving differential scores not only were plus and minus denotations employed but single and double crossings as well. An example will make the scoring device clear:
Case W.H.C., a 16-year old delinquent boy. On Test I the subject responded as follows to the differential items: XX carrying a revolver (+), XX bribery (-), X being conceited (-), XX gang (+), XX playing cards (+), X being a snob (-). No response was made to the item, prison. Summing the responses, double crossed items counting two, single crossed one, to positively denoted items +6 is obtained. Making the same computations for items negatively designated -4 is obtained. Adding algebraically the differential weighted score for Test I is 2. On Test II responses are: XX death (+), XX jail (+), X sins (+), XX dying (+). No response is made to the item, family. Since all differential items in this test are positive the differential score is the sum of single and double crossings, this being 7. On Test III the subject responded to only three of the six differential items: X joyriding (+), X circus (+), X candy (+). No response was made to church, movie star, and tap dancing. All items in Test III are positive. Since three items received one cross each the differential score for the test is 3. On Test IV the subject single-crossed five of the eight differential items: husky, quick, wealthy, well-dressed, and rich. Items, cooperative, good-looking, and handsome were ignored. Since all items to which responses were made are positive the differential score on Test IV is 5. Incidentally it should be noted that Test IV contains one minus item, cooperative, which if indicated by the subject necessitates an algebraic sum. To obtain a differential weighted score for the entire instrument the scores of the four tests were totalled. In the present case the total differential score is the sum of 2, 7, 3, and 5, or 17. If any single test

negative score, the total differential score was computed algebrai-

est possible differential weighted score on the Interest-Attitude
or the sum of all double-crossed positive items. The lowest possible
or the sum of four double crossed negative items. Differential
he control and experimental groups compared, therefore, distribute be-
xtremes indicated. The essential problem undertaken is one of deter-
hat extent the differential scores reliably discriminate delinquents
linquents.

STATISTICAL ANALYSIS

ons between delinquent and control groups was accomplished through
of the conventional formula for the critical ratio, $\frac{D}{PE\ (diff)}$, where
fference between mean differential weighted scores of similar and
age groups and PE (diff) is the probable error of difference between
ans.

frequency distributions of differential weighted scores, Table 1
omparative quartiles, standard deviations, medians, and means for four
oups of delinquents and non-delinquents; and (b) differences of means
trol and experimental groups with the resulting critical ratios.

Table 1

Comparison of Delinquents and Non-Delinquents in Differential Weighted Scores on Interest-Attitude Tests

p	No. of Cases	Q_1	Q_3	SD	Median	Mean	Diff. of Means	$\frac{D}{PE(diff)}$
elinquent	66	13.2	24.6	7.76	19.6	19.3		
on-delinquent	76	3.7	13.3	7.04	8.9	9.1	10.2	12.0
elinquent	75	11.4	24.0	8.74	16.9	18.2		
on-delinquent	101	4.5	13.0	6.77	8.7	9.3	8.9	10.9
elinquent	112	9.4	21.6	7.97	15.4	15.9		
on-delinquent	100	2.2	10.0	5.79	5.8	6.7	9.2	14.4
elinquent	63	9.5	19.0	7.65	15.1	15.3		
on-delinquent	97	1.3	9.2	6.68	4.2	5.9	9.4	11.8

$\frac{D}{PE(diff)}$ must be at least 4 to insure complete reliability, it is evi-
ll of the differences between means shown in Table 1 are significant,
al ratio being well in excess of the magnitude required.

interesting aspect of the comparative groups is seen in terms of over-
onsidering the life age groups from the point of view of median dif-
cores for delinquents, approximately 94 per cent of 14-year non-delin-
per cent of 15-year, 91 per cent of 16-year, and 92 per cent of 17-
below the median of the same life age groupings of delinquents. Or,
erently, about 6, 12, 9, and 8 per cent of the respective life age
, 15, 16, and 17 year non-delinquents, exceed the medians of similar
roupings of delinquents.

of more complete verification of the differences in personality charac-
between delinquents and non-delinquents the technique of differential
s been applied to two entirely new samples. One of these consists of a
3-year delinquents compared with a control group of similar life age.

The other consists of 115 delinquents of heterogenous life age, the median being 16.6 years. The latter sample was obtained practically five years after the original life age groups on the basis of which differential items were selected. As a control group for the latter, the differential scores of 374 non-delinquent subjects cited in Table 1 were pooled in one frequency distribution. Results of the last comparison are seen in Table 2.

Table 2

Comparison of Delinquents and Non-Delinquents in Differential Weighted Scores on Interest-Attitude Tests, Based on New Samples

Group	No. of Cases	Q_1	Q_3	SD	Median	Mean	Diff. of Means	$\frac{D}{PE(diff)}$
13-yr. delinquent	34	11.9	25.6	9.17	18.0	19.6		
13-yr. non-delinquent	61	4.0	14.9	7.97	9.1	10.5	9.1	7.2
Mixed ages, delinquent	115	10.0	20.7	7.47	14.8	15.3		
Mixed ages, non-delinquent	374	2.6	11.7	6.72	6.7	7.7	7.6	14.5

Differences between means shown in Table 2 are entirely reliable. The differences between control and experimental groups of mixed life ages are especially worthy of note. In terms of overlapping about 84 per cent of 13-year non-delinquents fall below the median differential score for delinquents, or 16 per cent exceed that median. In the mixed age group approximately 87 per cent of the control subjects are below the median for delinquents, or 13 per cent fall above that point.

It may be concluded from the foregoing analysis that a significant difference in personality exists between delinquents and normally adjusted subjects. That is, the constituent traits studied appear with a frequency among delinquents which reliably differentiate them from non-delinquents.

As a means of expressing an individual's emotional development Pressey (3) has proposed the concept emotional age. Emotional age may be derived from total scores on the Interest-Attitude Tests. In another connection the present writer (2) found that delinquents show on the average about two and one-half years emotional retardation. A possibility suggested itself that a relationship might exist between emotional ages and differential weighted scores of the juvenile delinquents. Hence, Pearson r's have been computed between the variables mentioned based on four life age groupings of delinquents appearing in Table 1. The resulting correlations appear in Table 3.

Table 3

Correlations between Emotional Ages and Differential Weighted Scores

Group	No. of Cases	r	PE
14-year delinquents	66	-.69	$\pm$.04
15-year delinquents	75	-.77	$\pm$.03
16-year delinquents	112	-.71	$\pm$.03
17-year delinquents	63	-.62	$\pm$.05

On the Interest-Attitude Tests the higher the score, based on the total examination, the less mature emotionally is the subject. For instance, a total score of 213 results in an emotional age of 10 years, while a total score of 14 gives

an emotional age of 18 years. Quite manifest, from the series of correlations in Table 3, is the fact that there is a highly significant and reasonably consistent negative relationship between emotional age and differential weighted score. This means that a tendency is present toward varying concomitance between emotional immaturity and differential scores of delinquents. Stated in other terms, subjects who have the highest scores on the Interest-Attitude Tests tend likewise to respond more often in terms of differential items.

A final aspect of the present investigation has to do with the relationship between differential weighted scores and degree of delinquency. The writer (1) has devised a method by which variations in the seriousness of delinquent careers may be estimated. Degree of delinquency is stated in terms of a delinquency index. As will be noted from Table 4 little meaning can be attached to correlations between differential weighted scores and degree of delinquency. Subjects used are the life age groups of delinquents found in Table 1 and later in Table 3

Table 4

Correlations between Differential Weighted Scores and Delinquency Indexes

Group	No. of Cases	r	PE
14 year delinquents	66	-.09	± .08
15-year delinquents	75	-.15	± .08
16-year delinquents	112	.13	± .06
17-year delinquents	63	.11	± .08

Although two of the foregoing correlations are negative and two positive, one characteristic in common is their insignificance. It is evident that two almost entirely different aspects of delinquent personality are measured by the devices the results of which have been correlated.

PRACTICAL CONSIDERATIONS

One indubitable fact may be observed from this study: within the limits of the traits differentiated, delinquents manifest a palpable difference from normally adjusted individuals. In relation to those circumstances which are considered wrong, cause worry or anxiety, elicit interest, or traits which are admired in others the delinquent presents an atypical picture. Of course, no contention is made that delinquents and non-delinquents fall into mutually exclusive groups in the differential traits. As has been pointed out there is some overlapping. The results suggest strongly, however, the possibility of employing the Interest-Attitude Tests as one means of anticipating delinquent conduct or apprehending delinquent tendencies which have not become overt. In the groups examined from 6 to 16 per cent of the control groups exceeded the median differential scores of respective delinquent groups. All of which may be interpreted as meaning that clinically one would be warranted in suspecting potential delinquency when an individual's score on the differential items exceeds a certain value. It is impossible to state specifically the magnitude of this crucial value. Medians of the six delinquent groups studied range approximately from 15 to 20. Interpreted conservatively it is likely that a score on the differential items of fifteen or more is sufficient evidence for an intensive study and follow-up of the individual case, even though no obvious delinquency has been recorded.

A fact however, which should not be overlooked is that differential scores are a function somewhat of higher total scores on the Interest-Attitude Tests. This brings retarded emotional development into the picture. Hence, two criteria are available in the differential diagnosis of suspected juvenile delinquency, viz., emotional age and differential weighted score. That is, if an individual is two and one-half or more years retarded in emotional age as compared with his life age and at the same time scores significantly high on the differential items, there is every reason for scrutinizing his behavior closely for possible delinquent tendencies.

From the standpoint of interpreting results a possible limitation of this investigation should be mentioned. All of the various experimental groups were subjects confined in an institution for juvenile delinquents. Whether or not differential items reflect certain attitudes, prejudices, and tendencies engendered by institutionalization cannot be stated definitely on the basis of the data at hand. An answer to the question will depend upon further experimentation, especially application of the method to non-institutionalized delinquent subjects and behavior problem cases in the public schools.

SUMMARY

Section two of a broader investigation of the personality characteristics of juvenile delinquents has been an attempt to test the reliability of a group of differential items methodologically ascertained in section one. That is, the primary purpose of the present section has been to discover to what extent the differential items were diagnostic of actual differences in personality between delinquent and non-delinquent subjects. In all instances in which comparisons have been made, significant differences have been demonstrated. Two relationships of the differential items have been found, one significant, the other without significance. In the first case it has been shown that differential weighted scores of delinquent subjects are related to emotional age. Secondly, it has been found that little or no relationship exists between differential scores and degree of delinquency. Some suggestions have been indicated as to possible ways of employing the Interest-Attitude Tests in the clinical analysis of delinquent behavior.

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A PRELIMINARY REPORT OF DARK ADAPTATION IN YOUNG INFANTS

JANET E. REDFIELD [1]

This article presents some preliminary findings of a study on the problem of dark adaptation of the infant eye.

Since the infant's responses to stimuli are characterized by much variability, the amount of bodily activity was employed as a criterion in a number of sensory studies by Irwin (1, 2), Weiss (9), Stubbs (8), Smith (7), and Richards (5, 6). It is the index adopted in the present investigation. Irwin and Weiss (3) and Smith (7) also studied the influence of visual stimulation upon crying. Accordingly a second measure, amount of crying, has been used as a possible index of dark adaptation.

Weiss (9) found that increasing the intensity of light resulted in a decrease in bodily activity. This result has been corroborated by Irwin and Weiss (4) and by Richards (5, 6). The hypothesis may be suggested that if the sensitivity of the infant's eyes could be increased and tested by a light of constant intensity, the same result found by the above workers should be obtained. Their method was to vary the light intensity while holding dark adaptation constant; here dark adaptation is varied and intensity is held constant. Theoretically, as the period of dark adaptation is lengthened the amount of body activity should decrease. The present study was undertaken to test this hypothesis.

The infant[2] was brought from the hospital nursery and placed on the stabilimeter within a Pratt experimental cabinet. All clothing except the diaper was removed, and the infant was left in the cabinet while the stabilimeter and recording apparatus were adjusted before beginning the experiment. Thus an interval of about five minutes was allowed to insure that the influence of handling might not affect the responses.

Each experiment consisted of three parts: (1) one minute of an adapting light, 47 foot candles, to insure uniform initial light adaptation of the eye; (2) one of four experimental periods of darkness which consisted of one, five, ten, and twenty minutes; and (3) five minutes of the control light, 1.5 foot candles. The adapting light was supplied by a 100 watt white frosted bulb, and the control light by a 7.5 watt frosted bulb.

All illumination was excluded from the cabinet during the dark period. The only light in the laboratory during the experiment was a small shaded bulb above the control board, supplying sufficient light for the experimenter to time and record observations. Experiments were performed during the last half of the interfeeding period when activity may be expected to be greatest.

Forty-seven infants ranging in age from seven to nine days were given 200 trials, fifty in each of four experimental periods. Twenty-three of the subjects were boys and twenty-four girls; twenty-five trials were made at each interval with each sex. The measure of response used was the number of active seconds per minute during the control light period following each interval of darkness; it

[1] From Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

[2] The subjects were available through the courtesy of Dr. E. D. Plass, head of the Department of Obstetrics and Gynecology in the hospital of the State University of Iowa.

CHILD DEVELOPMENT, Vol. 8, No. 3 (September, 1937)

was recorded by means of an electric stabilimeter and polygraph. In addition quarter-minute observations were made of eyes open or shut and whether the infant was silent or crying. The per cents of agreement in counting activity records between the experimenter and two assistants were 97 and 99 respectively; 100 per cent agreement was obtained for observations of condition.

RESULTS

The data[1] have been analyzed (1) for the group as a whole, (2) for sex differences, (3) for crying and silent subjects, and (4) for infants with eyes open and eyes closed.

The Group as a Whole

Mean Activity.- Mean activity for the group as a whole following each of the experimental intervals, together with the standard deviation of each distribution and the standard errors of the means, are found in the following tabulation:

Adaptation Time (Minutes)	Mean	Standard Deviation of Distribution	Standard Error of Mean
1	16.6	18.1	2.6
5	13.6	15.8	2.2
10	12.2	14.2	2.0
20	9.4	12.5	1.8

It will be seen that bodily activity decreases as the time of dark adaptation is lengthened (Figure 1). The significance of the differences between activity in each of the periods following dark adaptation is as follows:

Adaptation Time (Minutes)	Ratio of Difference to Standard Error of Difference	Chances in 100 Difference Is Greater Than Zero
1 and 20	2.31	99
5 and 20	1.48	93
10 and 20	1.03	85
1 and 10	1.35	91
5 and 10	.47	69
1 and 5	.88	82

While the differences in mean activity following these intervals of dark adaptation are not statistically significant, the difference is always in the same direction. The largest value for the critical ratio is 2.31. It occurs in the case of activity following dark adaptation periods of one and twenty minutes, which indicates that if the experiment were repeated under like conditions the chances are 99 in 100 that the difference in bodily activity would be as great.

Change in Activity Between Long and Short Intervals.- Another method of analyzing the data is to determine the per cents of infants showing increases, decreases, and no differences in activity in short versus long intervals. The results of this analysis for the cases in which the same infant served as subject for both a long and a short period are shown below:

	Adaptation Time, Minutes	
	1 and 20*	5 and 20**
Per cent of cases showing increase	37	25
Mean increase of activity	11.4	3.1
Per cent of cases showing decrease	50	40
Mean decrease of activity	20.5	17.8
Per cent of cases showing no change	13	35

*24 cases **20 cases

[1] The original data upon which this report is based may be found in the appendix of the manuscript copy on file in the University of Iowa Library.

It is apparent from this tabulation that the mean decrease in both comparisons is several times the increase, although the per cent of infants showing a decrease in activity is low.

Percentiles.- An analysis of the data by percentiles has also been made. The tabulation shows that the 90th, 75th, and 60th percentiles give the same trend as revealed by the means; that is, that activity decreased with increase in the length of the dark adaptation period. The two lower percentiles, however, are not consistent, probably because some infants exhibited little activity.

Percentiles	Dark Adaptation Time, Minutes 1	5	10	20
90	43.5	40.5	37.5	30.0
75	31.8	27.0	17.0	13.0
60	17.5	13.5	11.5	5.7
50	10.5	6.5	7.5	3.2
25	.7	.5	1.2	.3

Immediate Response to Change: The First Minute.- Two analyses of response to change from darkness to light have been attempted. The frequency of change in general level of activity from the last minute of darkness to the first minute of light for each of the experimental intervals is shown below:

Change in Activity	Time in Darkness, Minutes 1	5	10	20
Increase	3	2	4	1
Decrease	8	12	13	11
No change	39	36	33	30

It is evident from this analysis that the immediate response cannot be used as a measure of dark adaptation when change in activity is the criterion.

Mean activity in the first minute of light after darkness is the second measure used. The means for the four intervals are respectively 17.4, 13.7, 11.3, and 8.1. The critical ratio of the means after one and twenty minutes in darkness is 2.62, indicating that there are 99 chances in 100 for a difference between the true means. The coefficients of correlation between these results and the means of the five-minute period are .82 ± .05, .48 ± .11, .88 ± .03, and .85 ± .04.

Per Cent of Crying.- Smith (7) found that per cent of crying was a reliable measure of the response of infants to the brightness of three hues. The frequencies of crying after each period of dark adaptation in the present experiment are 35.3, 30.7, 33.4, and 24.6 per cent respectively. Thus while there is a reduction in amount of crying from the shortest to the longest interval, the decrease is not progressive.

Sex Differences

For purposes of comparison, the means in activity for boys, for girls, and for all cases are shown in the following tabulation and in Figure 1:

Adaptation Time (Minutes)	Boys	Girls	All Cases
1	16.7	16.[illegible]	16.6
5	1[illegible].[illegible]	11.5	13.6
10	1[illegible].[illegible]	12.7	12.[illegible]
20	[illegible].7	10.[illegible]	[illegible].4

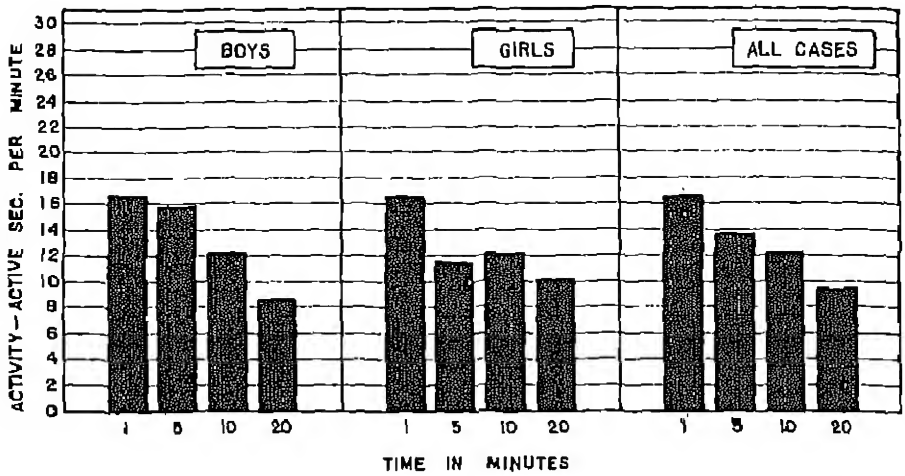

Figure 1. Mean Activity for Boys, for Girls, and for all Subjects.

It will be seen that differences in activity between the sexes are negligible after one and ten minutes of darkness; after five minutes the boys are more active, and after twenty minutes the girls.

The per cents of crying for the two sexes are given below:

Adaptation Time (Minutes)	Boys	Girls
1	38.2	32.4
5	36.2	25.2
10	39.6	27.2
20	23.6	25.6

The boys consistently cry a greater part of the time, except after twenty minutes of darkness.

Crying and Silent Subjects

The effect of a distinction between crying and silent subjects is to eliminate those who were asleep during the whole or greater part of the experiment. Mean activity for these groups in the experimental intervals, together with the number of subjects in each case, is given below:

Adaptation Time (Minutes)	Infants Crying Number	Infants Crying Mean	Infants Silent Number	Infants Silent Mean
1	28	28.36	22	1.68
5	29	23.12	21	.53
10	33	18.03	17	.95
20	26	17.62	24	.56

Infants With Eyes Open and Those With Eyes Closed

An analysis of those infants whose eyes were open 50 per cent or more of the time and those whose eyes were closed 50 per cent or more of the time should evaluate the importance of these factors. However, because of the small number of

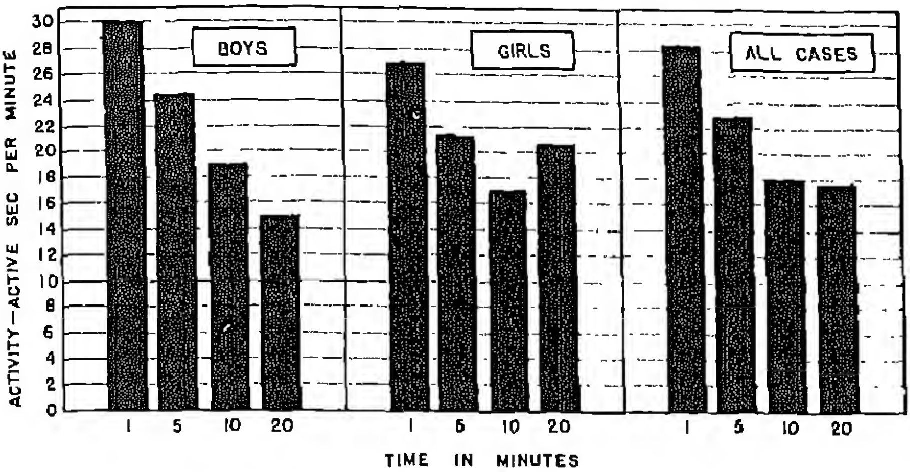

Figure 2. Mean Activity for Crying Subjects

cases in which the eyes were open, no detailed statistical procedure could be used. The means in activity and the numbers of infants showing these conditions are given below:

Adaptation Time (Minutes)	Eyes Open Number	Eyes Open Mean	Eyes Closed Number	Eyes Closed Mean
1	10	14.8	43	16.8
5	7	8.6	44	14.5
10	12	11.1	40	12.4
20	7	9.7	44	9.4

From these data it is seen that the infant whose eyes are closed gives results consistent with findings for the whole group. It thus appears that activity is inhibited following increased duration of darkness even though the eyes are closed.

SUMMARY

The following tabulation summarizes the criteria which give consistent results in measuring the responses of infants to a constant intensity of light after varying degrees of dark adaptation:

Criterion	Adaptation Time, Minutes: 1	5	10	20
Mean activity, 5 minutes	16.6	13.6	12.2	9.4
Mean activity, 1 minute	17.4	13.7	11.3	8.1
Mean activity, crying subjects	20.4	23.1	10.0	17.6
90th Percentile	43.5	40.5	37.5	30.0
75th Percentile	33.8	27.0	17.0	13.0
60th Percentile	17.5	13.5	11.5	5.7

This tabulation summarizes the criteria which give inconclusive results:

Criterion	Adaptation Time, Minutes			
	1	5	10	20
50th Percentile	10.5	6.5	1.5	3.2
25th Percentile	.7	.5	1.2	.3
Frequency of immediate decrease in activity in light after darkness	0.0	12.0	13.0	11.0
Per cent of crying subjects	35.1	30.7	33.4	24.6
Mean activity, silent subjects	1.7	.5	1.0	.6

These results may be summarized as follows:

1. Mean activity - whether over a five-minute period or for one minute - in constant light after dark adaptation decreases with lengthened periods of darkness from one to twenty minutes. The coefficients of correlation between these two measures after one, five, ten, and twenty minutes in darkness are respectively .82 ± .05, .48 ± .11, .88 ± .05, and .85 ± .04.

2. On the basis of bodily activity, the crying infant shows a more consistent response to dark adaptation than does the silent one.

3. The 90th, 75th, and 60th percentiles show consistent results; this is not true of the lower percentile ranks, probably because of the large numbers of inactive or slightly active infants.

4. The frequency of immediate response to light fails as a measure of dark adaptation.

5. Per cent of crying in light decreases with lengthened dark adaptation, except following the ten minute period.

6. The responses of infants with eyes closed show a high degree of consistency with the results for all subjects; the inconsistent results given by infants with eyes open are probably explained by the small number of the cases in which this condition was found.

7. The boys are slightly more active than the girls, except following the twenty-minute period; they are also less variable.

8. The boys cry a greater per cent of the time than do the girls, except following the twenty-minute period.

The present study presents evidence concerning the adequacy of the criteria used for measuring the dark adaptation of the infant eye. It has been shown that bodily activity decreases following lengthened periods of dark adaptation, but in no case has statistical significance been obtained between activity levels. However, there are 99 chances in 100 that the difference between the results of the shortest and longest dark adaptation periods is a true difference. It follows that this measure is adequate to detect differences in the sensitivity of the infant eye after dark adaptation.

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DEVELOPMENT IN THE USE OF PROPER NAMES

EDITH A. DAVIS [1]

The proper names used by 436 children in 21,800 remarks were recorded under a standardized situation [2] and were found to show certain well defined age differences. Subjects were selected at three discrete age levels, 5 1/2, 6 1/2, and 9 1/2 years, on a percentage basis that was representative of the Minneapolis-St. Paul population, the father's occupation being the criterion. The grade location of subjects was for the most part kindergarten, first grade, and fourth grade. Individual interviews during school hours lasted in each case until 50 remarks were recorded.

With two exceptions, the numerical importance of proper names in children's language proved to be slight. The subjects were given an opportunity to play with a collection of Wild West toys. Probably because of this fact the word Indian occurred, 1,658 times, and ranked fifteenth in the list of all words used. Christmas was noted 88 times. These two words, as well as other names of months, days, and holidays; words describing nationality, and names of deity, were listed in the regular manner, and the category of proper names was reserved for names of specific persons and places. Aside from the terms Indian and Christmas, names in the above categories were of little importance in the final tabulations, since only 32 expressions were involved. The inclusion of Indian and Christmas, however, would have given so distorted a picture that the decision to limit the category to persons and places seems a wise one.

The number of proper names used per child was slightly less at 9 1/2 years than at the earlier levels, both absolutely and when related to the total words used per child, as is shown in Table I.

Table I

Mean Number of Proper Names

Age in years	Number of Subjects	Total number proper names	Mean per child	Per cent of all words per child	Total number different proper names	Mean per Child	Per cent of mean number different words
5 1/2	240	260	1.08	0.5	197	0.79	0.8
6 1/2	63	87	1.38	0.5	56	0.89	0.8
9 1/2	125	111	0.89	0.3	93	0.74	0.6

More detailed analysis indicated that the persons named by the young child tend to be friends, teachers, and members of the family, while the older child mentions historical and fictitious characters. Table II shows the distribution of surnames by age.

A similar name trend appeared in the analysis of places mentioned. The young child refers to local places - schools, parks, his father's place of business, his own street or telephone number - while the older child mentions places at a

[1] From the Institute of Child Welfare, University of Minnesota.

[2] Davis, Edith A. The Development of Linguistic Skill in Twins, Singletons with Siblings, and Only Children. University of Minnesota, Institute of Child Welfare Monograph Series Number XIV. In Press.

Table II

Distribution of Surnames Used

Age in Years	Friends	Teachers	Members of Family	Total	Mean Per Child
5 1/2	24	15	1	40	.16
6 1/2	2	2	1	5	.08
9 1/2	7	0	1	8	.06

distance, other states, and foreign countries. At the kindergarten age the child is still fascinated by names as names, and the distinction of individuals by this means remains of major importance. By 9 1/2 years all this has become an old story, but there is a delight in discussing Hiawatha, California, and Holland.

The 248 5 1/2 year old children used 69 different Christian names, which is a ratio of one name to each three children. This ratio declines to one name for each five children at 9 1/2 years. Table III shows this relation and in addition gives the ratios for the number of different names used, i.e. with repetitions of the same name excluded.

Table III

Mean Number of Christian Names

Age in Years	Total Names	Mean per Child	Number of Different Names	Mean per Child
5 1/2	75	.30	69	.28
6 1/2	20	.32	9	.14
9 1/2	24	.19	21	.17

Thirteen of the Christian names occurred three times or oftener. All except one of these (Elaine) appears in Thorndike's list of 20,000 words. Leonard and Jimmie are found in Thorndike's sixth thousand, the other ten names in the first five thousand. The names, with their frequencies, are given in Table IV.

Table IV

Distribution of Christian Names

Name	Times used	Thorndike
Billy	12	3b
Betty	9	4a
Jimmie	9	6
Tom, Tommy	5	3a, 5a
George	6	2a
Dick	4	2b
John	4	1a
Jack	3	2a
Mary	4	2a
Dorothy	3	3b
Walter	3	3b
Leonard	3	6
Elaine	3	-

George Washington and Buffalo Bill were the only historical personages mentioned by the 5 1/2 year olds. Santa Claus, Little Black Sambo, Tarzan, Wolfpaw, and Little Bo Peep were the fictitious characters to whom they alluded. At 9 1/2 years eight historical and nine fictitious characters were mentioned. The distribution of the reference to such characters is shown in Table V.

Table V

Distribution of Historical and Fictitious Characters

Historical	Ages 5 1/2	Ages 6 1/2	Ages 9 1/2	All Ages
George Washington	9	3	1	13
Buffalo Bill	3		4	7
Kit Carson			2	2
Custer			2	2
Abraham Lincoln, Mohicans, Radisson, Groseilliers (1 each)				4
Fictitious				
Santa Claus	28	5		33
Little Black Sambo	13	21	3	37
Tarzan	2			2
Wolfpaw	2		1	3
Bo Peep	1			1
Tom Sawyer		3		3
Hiawatha			3	3
"Frederick"			2	2
Redwing, Jack Frost, Old Mother Hubbard, "Billy" (1 each)				4
Great Spirit, "Polly", Buck Jones, Peter Rabbit, Alice in Wonderland (1 each)				5

We may conclude that as a child develops he is less likely to name the persons and places associated with his every day life. His casual conversation, however, does reflect his increasing familiarity with faraway places and with historical and fictitious characters.

MOTIVATING FACTORS IN CHILD LEARNING

ELISABETH T. HAST[1]

There are many problems of motivation with young children which need to be investigated. There are few studies on the influence of incentives on young children and the motivating factors in the experiments on learning in young children give few data for evaluation of incentives and rewards. The present experiment was run as the second series in an experiment by Johnson.[2] It was planned to test the influence of an intrinsic reward plus an unpleasant incentive on the speed of learning to open a simple problem box.

METHOD

The method was in general experimental. The learning problem was presented to each subject individually. A period of five minutes was chosen as the maximum length of a single learning period, since it is difficult to get the child's attention to one problem for a long period. Learning periods were given at intervals of two to three days until the problem was mastered. A retest was given approximately one week after the first success. Five of the subjects were given a retest seven months later.

SUBJECTS

The subjects were forty-three children enrolled in the Johns Hopkins University Child Institute during nineteen thirty-six and nineteen thirty-seven. Two of the children did not complete the test due to withdrawal from school and three refused to cooperate on the test. For convenience in analysing the data the subjects are considered in two groups. Group A was composed of twenty-three children who were tested and retested in May nineteen thirty-six; Group B was composed of twenty children tested in December nineteen thirty-six. The range in chronological age of the subjects in Group A was from thirty months to seventy months with an average of forty-five and nine-tenths months; the range of those in Group B was from twenty-two months to fifty-nine months with an average age of forty months. All ages were taken from the date of the first presentation.

The range in I.Q. as indicated by the Minnesota Preschool Scale was from seventy-two to one hundred and forty-one with an average of one hundred and nineteen for Group A and from fifty to one hundred and twenty-eight with an average of one hundred and sixteen for Group B. These scores are not assumed to be reliable indices of the mental abilities since some children give poor attention or cooperation on the test. Intelligence scores for young children can do no more than act as an indication of the general level of intelligence of the children. The subjects came from average and above average homes as rated by economic status.

[1] From The Child Institute, Johns Hopkins University.

[2] Buford Johnson. Variations in emotional responses of children. Child Development, 1936, 7, 2.

CHILD DEVELOPMENT, Vol. 8, No. 3 (September, 1937)

APPARATUS

The apparatus consisted of a wooden box, nine inches by five inches by five inches, with a glass top hinged at the back. The box could be opened by inserting a stylus in a quarter inch hole in the center of a one inch brass plate on the front of the box which released the catch holding down the top of the box. An illustration of the box appears in an article by Johnson. The apparatus was so wired that an ordinary doorbell rang when the stylus came in contact with the plate.

The problem box was placed on a low white table with the stylus placed to the right of the box. A small kindergarten chair for the subject was put directly in front of the table. A chair for the experimenter was placed to the left and slightly behind the subject's chair.

The reward incentives were placed inside the problem box and were visible through the top of the box. The rewards used were small toy rubber autos from F. W. Woolworth's. All of the cars used in the first presentation were red and of the same model. Those used in the retest were green or blue and were of different models.

TESTING PROCEDURE

The children were obtained from the group by the experimenter and taken individually to the experimental room. After the child had been seated, the experimenter said, "Do you see what is in this box? When you have opened the box you may have it. You must take this in your hand (the experimenter handed the stylus to the child) and open the box with it." Time with a stop-watch was taken from the moment the directions were completed until the box was opened or until five minutes had elapsed. If the child failed to open the box in five minutes, the experimenter suggested that the child come back another day to open the box. Running notes of the speech of the child and of his overt emotional behavior during the testing period were taken. If the child attempted to open the box with his hands the experimenter said, "No, you must open it with this (the stylus)." The same directions were used on succeeding trials except that the experimenter said, "You know what is in this box, don't you?, etc." Questions of the subjects during the testing period were answered briefly and without giving any clue to the solution of the problem. To the numerous requests for the experimenter to open the box, she replied, "I know you can do it yourself. When you have opened the box then you may have the car to take home." Encouragement was given whenever it seemed advisable.

The subjects in Group A were given a retest several days after success on the first test. At the close of this test the experimenter asked, "How do you open the box?" Verbal replies and the method of demonstration were recorded. No retest was given to the subjects in Group B since the time scores for the retest of Group A showed that the problem was thoroughly mastered during the first trial and also since many of the time scores on the first test for Group B were so small that no improvement would be possible. The subjects in this group were therefore asked how to open the box after the first success.

ANALYSIS OF EXPERIMENTAL RESULTS

The results of this investigation have been studied: (1) relative to age and

I.Q. as a factor in the speed of mastering the problem; (2) the emotional factors involved; (3) the relative influence of the motivating factors employed; (4) a comparison of the results of Group A and of Group B.

THE INFLUENCE OF AGE AND I.Q.

The time scores, age and I.Q. of the subjects in Group A are presented in Table I; those of Group B are given in Table II. An examination of these Tables indicates that there is no relation between either age or I.Q. and the time score. In Group A the youngest and the oldest child learned the problem with almost equal rapidity. The highest and the lowest scores were distributed throughout the age range. The situation in Group B was found to be similar. Of the two children in Group A who obtained the highest scores on the intelligence test, one had one of the smallest time scores and the other had the largest. The child who had the smallest time score also had the lowest I.Q. Although the I.Q. scores for Group B are incomplete, no correlation between the I.Q. and the speed of learning is evident.

EMOTIONAL FACTORS

From a study of the verbal remarks of the subjects in relation to the time scores presented in Table I and II, there appears to be some correlation between the emotional factors involved and the speed of mastering the problem. In nearly all of the instances in which the time scores were large, the subjects showed emotional disturbance and usually made some verbal comment indicating a dislike for the sound of the bell. Only three children in Group A and one in Group B stated that they enjoyed the sound of the bell and wished to ring it just for the sake of the noise. Eight children in Group A and three in Group B expressed a definite dislike for the noise. Johnson had analysed the emotional factors involved in the learning of this problem by the subjects in Group A. There appeared to be less emotional disturbance in Group B than in Group A.

All but two of the subjects in Group A reduced their time on the second trial. W. G.'s score on the sound performance was only slightly higher and it is probable that she opened the box by mistake the first time. T. B.'s scores were almost identical. The speed of opening the box on the second trial does not appear to depend on age or I.Q. Since no unusual nor significant results were obtained on the second presentation with Group A and since the time scores obtained by Group B were already very small, only one trial was given to the subjects in Group B.

The results of the five subjects retested after seven months are given in Table III. H. L., who had refused to do the experiment after the first sound of the bell, continued to be non-cooperative. Of the other four, two of the children reduced their time scores and the other two increased their time scores. The two who reduced their time scores had asked for "the game with the box and the autos" several months before the retest was given. The subjects who took longer to open the box appeared to remember only a part of the principle involved so had to unlearn this before they could relearn the correct principle.

Some of the children had apparently ascertained the principle of the box before they opened it. P. T. said, "I don't want the bell to ring when I put it (the stylus) against there (the plate). Where else shall I put it to open the box?" After three hundred seconds S. A. said, "I have to ring it before it opens' but

Table I

Subject	Time score in sec. Trial 1	Time score in sec. Trial 2	Age in months	I.Q.	Emotional disturbance as indicated by overt behavior or verbal comments.
T.B.	32	35	36	72	None
Y.B.	65	21	36	123	None
S.C.	67	2	64	135	None
W.C.	70	167	47	108	Slight
M.K.	110	2	70	114	None
W.E.	115	2	30	141	None
S.L.	120	20	53	126	Slight
L.M.	200	155	37	108	None
S.F.	215	145	53	126	None
M.M.	240	4	36	130	None
T.J.	305	4	64	137	None
T.M.	345	176	44	117	"I don't like that noise."
Z.J.	366	2	48	117	"I don't like that noise."
K.J.	452	9	31	118	"Bell hurts my ears."
H.K.	613	212	37	111	"That big noise scares me to death."
H.R.	860	89	37	102	None. Was fascinated by the sound.
L.H.	917	4	49	121	Jumped each time bell rang.
S.A.	947	94	36	119	"May I ring?" Fascinated by the bell.
K.N.	1130	182	69	193#	Showed a definite dislike for bell.
D.D.	1204	190	53	103	Jumped each time the bell rang.
J.P.	1498	6	38	141	Slight, Experimented with methods of ringing bell.
M.W.	refused		38	119	As soon as the bell rang said, "No I won't touch it."
N.L.	refused		49	126	As soon as bell rang darted out of the room and refused to return.

- Measured on the Stanford Binet scale.

Table II

Subject	Time score in sec.	Age in months	I.Q.	Emotional disturbance as indicated by overt behavior or verbal comments.
H.C.	2	38		None
P.T.	2	37	105	None
K.H.	2	38	112	None
H.N.	3	22	96	Screamed when the bell rang but had already opened the box.
L.P.	3	35	102	None
M.R.	3	47	131	None
S.H.	6	32	95	None
B.S.	7	46		None
M.B.	8	37	50	None
B.J.	38	48	130*	Slight
M.S.	40	44		None
M.E.	60	42	120	None
F.B.	70	24		None
P.J.	393	29		None. Was fascinated by the sound.
Z.V.	591	49		None
D.F.	935	59	126*	Deep breathing and facial expression showed emotional disturbance.
D.M.	not completed	39	120*	"It scared me." "Where is the hole you put it in?"
P.T.	not completed	56		"I don't want the bell to ring."
D.T.	refused	34	126	"If I put this in it will ring." Refused to cooperate but opened the box in ten seconds after the bell was discontinued.

* - Measured on the Stutsman Test.

she took nine hundred and forty-seven seconds to open the box. H. N., after one hundred and eighty seconds, said, "You open it down here but it's going to ring." However, none of those children distinguished between the sound of the bell and pushing with the stylus as the effective factor in opening the box. T. J. was the only child to do this. She said on her retest, "The bell doesn't open the box, does it?" Several of the children gave as an explanation for the method of opening the box, "You ring down here." On her retest seven months later, T. M., said, "It looks like it's coming open every time I ring the bell. ...I think if

Table III

Subject	Time score in sec.	Age in months	I.Q.	Emotional disturbance as indicated by overt behavior or verbal comments.
H.R.	3	44	102	Made no remarks but opened the box immediately.
J.P.	3	45	141	Before she entered the room, she told how to open the box.
T.M.	403	51	117	Disturbed by the noise. Said, "It looks like it's coming open every time I ring the bell."
Y.B.	780	43	123	No disturbance but seemed to have forgotten a part of the principle. Kept stylus on the plate most of the time.
H.L.	refused	56	121	She suggested coming to the experimental room but would not enter the room. She stood in the doorway and talked about the unpleasantness of the bell.

I make a big noise it might get out or pop out." It was difficult to determine whether children actually understood the principle since many of them gave no verbal clue as to their comprehension, the majority of them merely demonstrating how they had opened the box when they were asked for the principle.

INFLUENCE OF THE MOTIVATING FACTORS

The emotional influence of the bell has already been discussed. The comments of the children indicated that the autos were very desirable objects. The sound of the bell focused the attention on the plate which was the clue to opening the box. The auto kept the attention of the child on the problem at hand. In most cases the reward incentive seemed to be stronger than the unpleasant incentive of the sound of the bell since nearly all of the subjects overcame their dislike for the bell in order to obtain the auto. Encouragement, which was given by the experimenter whenever it seemed necessary, kept some children at the problem when they seemed about ready to give up.

COMPARISON OF THE GROUPS

The time scores for the subjects in Group A are in general much larger than those for Group B. Nine of the children in Group A and only five in Group B showed disturbance at the sound of the bell. The procedure for the two groups was identical except that no retest was given to the subjects in Group B. Although the two groups were not matched for age and I.Q., the averages for the groups show that Group B is composed of only slightly younger and of approximately equally intelligent children as those found in Group A. Furthermore, it has already been indicated that speed in accomplishing the task was not dependent upon the age or the I.Q. of the subjects but rather upon the emotional factors involved in the performance of the task. An analysis of external factors which might cause greater disturbance in Group A than in Group B was, therefore, made. Shortly before the subjects in Group A were tested in the present experiment, they were used in an experiment by Johnson. The problem involved tracing a maze with a stylus wired so that when the stylus came in contact with the side of the pathway, a bell rang and a slight electric shock was administered. The bell used was the same as the one employed in the present experiment. The subjects in Group B had had no experience with a stylus nor with the bell before the outset of the present experiment. It seems probable therefore, that there was a carry-over from the previous

experiment which acted as a confusing factor in the present experiment.

INTERPRETATION OF THE RESULTS

The speed of learning to open a simple problem box does not appear to be correlated with age or I.Q. There is a tendency for those subjects who were definitely disturbed by the sound of the bell to take longer to open the box than those subjects who were not disturbed by the bell. The difference in time scores obtained on the two groups gives indications that the apparent emotional disturbance strongly influenced the time. In general the reward incentive seemed to act more strongly than the unpleasant incentive of the sound of the bell. Encouragement tended to give the subjects self-confidence when they were discouraged with the problem. Some factors outside the control of the immediate experiment may have influenced the results, such as the success of other children in obtaining a toy.

RACIAL DIFFERENCES IN REACTION TIME AT THE PRESCHOOL LEVEL

CATHERINE HARMON[1]

During the present century there has been a great interest in racial differences in mental ability. Other aspects of racial differences have been somewhat neglected because of this consuming interest in comparative intelligence quotients. The present study was undertaken to determine whether or not racial differences are apparent in the simple reaction time of children.

Previous experiments in this field have been inconclusive. Bachs (1) asserted that speed of reaction varied inversely with intelligence, though some of his observations appear not to support this view. Klineberg (3), who tested rural and urban groups of Indian, white, and negro children, maintained that racial differences on performance tests were entirely speed differences, and that these were due to environmental factors. Lambeth and Lanier (4) made an intensive study on racial differences in speed of reaction, their subjects being thirty 12-year-old whites and thirty 12-year-old negroes. Their results show no race differences in speed of simple manual movement, but as the performance becomes more complex the whites exceed the negroes in proportion to the complexity. Goodenough's (2) study of preschool children shows a low positive correlation between scores on certain intelligence tests in which speed is a factor and simple reaction time. Other researches in which sensation was the chief classification indicate that the measurement of reaction time provides a rough measure of ability in the sense category concerned.

In the present experiment, the following subjects were used:

30 Italian children, aged 3 1/2 to 6 1/2
30 Mexican children, aged 3 1/2 to 6 1/2
32 Negro children, aged 3 1/2 to 6 1/2
28 Jewish children, aged 3 1/2 to 6 1/2
13 Indian children, aged 4 1/2 to 7 1/2

Most of these children were from the lower socio-economic groups. This fact is, however, in all probability of little or no importance since Goodenough (2) found no relationship between speed of simple reaction and socio-economic status. The sexes were fairly evenly distributed at each age level.

The apparatus used was the Miles Reaction Time Board. This was placed on a low table with the child seated in front and the experimenter to his left. Preliminary trials were given until the child gave evidence of understanding what he was supposed to do. Then alternate trials were made with each hand until a total of twenty, ten with the right hand and ten with the left, had been recorded. The general procedure and instructions were the same as those used by Goodenough.

The median, expressed in sigma units, was found to be the most accurate measure of reaction speed in this test. Prolonged and premature reactions are included in the results, except in those cases in which the child's attention was obviously distracted. In these cases the trial was repeated. An auditory stimulus (sound of a buzzer) was used. At these age levels, control of the type of reaction

[1] From the Institute of Child Welfare, University of Minnesota.

(muscular or sensory) is practically impossible, hence the reactions probably include both types. Diffused reactions of the kind described by Luria occurred at all age levels and in all racial groups.

Results of the experiment are given in Tables 1 and 2. They show that the Italians, at all age ranges tested, react more quickly than any of the other races, and also appear to be more stable, since the average of the mean variations from the individual median is smaller. Individual differences are marked in all ages and races. The Indians were found to be slower than any of the other races. This finding is contrary to those of Bache (1) and Myers (5), and since the number of cases is so small, may easily be due to chance.

Table 1

Mean Reaction Speed* (in Sigma Units) and Mean Variations from the Mean, for Groups of Children of Six Races at Four Age Levels

	Italians			Mexicans			Negroes			Jews			Indians			Amer. Whites[1]		
Age	No.	Mean	MV	No.	Mean	MV	No.	Mean	MV	No.	Mean	MV	No.	Mean	MV	No.	Mean	MV
3 1/2	10	409	03	4	520	98	4	442	95	0	632	125	0			53	601	239
4 1/2	10	344	57	11	437	89	13	436	05	8	485	99	5	521	120	57	432	132
5 1/2	10	326	47	12	453	80	14	354	62	12	361	74	0			111	389	123
6 1/2				3	357	74	3	315	70	3	331	74	4	440	75	59	296	73

* Based upon individual means

Table 2

Mean Reaction Speed* (in Sigma Units) and Mean Variations from the Median, for Groups of Children of Six Races at Four Age Levels

	Italians			Mexicans			Negroes			Jews			Indians			Amer. Whites[1]		
Age	No.	Mean	MV	No.	Mean	MV	No.	Mean	MV	No.	Mean	MV	No.	Mean	MV	No.	Mean	MV
3 1/2	10	379	84	4	450	96	4	414	90	8	568	122	0			53	505	231
4 1/2	10	344	56	11	418	85	13	346	82	8	421	99	5	487	114	57	390	121
5 1/2	10	308	52	12	454	77	14	331	61	12	333	70	0			111	334	116
6 1/2	0			3	315	74	5	267	70	3	329	75	4	433	125	59	273	69

* Based upon individual medians

The mean variations of the Indian children were larger than those of the other races, seeming to indicate a more primitive type of reaction in the Indians. The Jewish group was slower than any except the Indians at all levels except 5 1/2 years, at which the Mexicans were slower than any group except the Indians. The Negroes rank next below the Italians in speed throughout all the age ranges. The medians indicate that the Italians were only a little speedier than the Negroes, but the Italians' mean variations from their median scores are proportionately less than the Negroes', which, as Goodenough (2) has shown, is further indication of a more mature type of reaction. The tendency to diffuse reaction, characteristic of young children, is at all ages less marked in the Italians than in the other races. The American white children studied by Goodenough consistently maintain an intermediate rank among the other natio-racial groups included in this study. Further work on this point is desirable because of the small number of subjects in the present study.

This investigation suggests that there may be true racial differences in reac-

[1] The data on American white children are taken from Goodenough's study (2).

tion time. The Italian children showed a more mature type of reaction, age for age, than the other groups tested.

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A STUDY OF NURSES' ATTITUDES TOWARD THE BEHAVIOR PROBLEMS OF CHILDREN UNDER HOSPITAL CARE

HAZEL H. BOWLES [1]

Although Wickman, Stogdill, and others have studied the attitudes of parents and teachers toward children's problem behavior, no study has yet been made - so far as the writer has been able to ascertain - of the attitudes of nurses who care for school-age children in hospitals. The present study was carried out in an attempt to obtain data on this aspect of the question.

Previous studies of the attitudes of adults toward children's behavior problems have indicated that persons with little or no knowledge of mental hygiene tend to rank as fairly or very serious those problems that involve actions conflicting with the social code, and that they underrate the significance of withdrawing tendencies, recessive personality, and behavior traits, which mental hygienists regard as most serious. Stogdill (5) compared the ratings given various behavior problems by parents and by mental hygienists. The ratings of his mental hygienists agreed for the most part with those of the Wickman study; while parents, like teachers, were inclined to rate overt behavior problems as the more serious.

Bain (2) found that Teachers College students come nearer to the mental hygiene point of view on problem behavior after they had had one or more courses in child study. Preston and Shapler (4) comparing a group of supposedly normal grade school children with a group classed as needing psychiatric treatment found that the control group could not be distinguished from the clinic group on the basis of behavior traits. Temper tantrums, for instance, occurred in an equal percentage of both groups, while daydreaming was more prevalent in the control group than in the clinic group. This indicates the wide variance in opinion as to what different people consider as "problems". McFie (3) concluded from a study of children referred to a psychiatrist that parents tend to regard active disturbing behavior as much more serious than the personality deviations that give concern to the psychiatrist.

Only one recent investigation, that of Arlitt and Lloyd (1), has involved a study of the problem behavior exhibited by children in hospitals. These authors, however, studied preschool children, and their aim was to discover the effect of hospitalization as a factor in producing behavior problems. The object of the present study was to learn the attitudes of nurses toward various types of problem behavior, rather than to search into possible causes of the behavior. Future studies may be able to combine the two points of view and thus add to our knowledge of the cumulative and interactive effects of behavior.

Subjects and method.--It was not possible to find a group of nurses comparable in both education and term of service to answer the questions used in this study, under even partially controlled conditions. The subjects used were student nurses who had had some experience in pediatric nursing and graduate nurses actively engaged in nursing children. Some of both groups had had only high school education before their hospital training, while others had had a year or more of college work. Many of the college girls had completed a four-year course. Some

[1] From the Institute of Child Welfare, University of Minnesota.

CHILD DEVELOPMENT, Vol. 8, No. 3 (September, 1937)

nurses in both groups had had nursery school experience. Altogether there were 224 nurses from seven university hospitals. There were 83 student nurses and 17 graduates who had had some college work, and 88 students and 30 graduates who had only high school.

The questionnaire sent to the nursing schools consisted of 60 items selected from both the Wickman (6) and the Stogdill studies as likely to be applicable to children of school age in hospitals. The questionnaire is given below.

Key to Rating Scales

I. Frequency	II. Seriousness (present)	III. Seriousness (future)
a. *None*	a. *No consequence*	a. No importance at all
b. Very small number	b. Only of slight consequence	b. Only slight importance
c. In about $\frac{1}{4}$ of all	c. Makes considerable difficulty	c. Considerable importance
d. In nearly all	d. Extremely grave problem	d. Extremely grave importance

1 — a b c d; 2 — a b c d; 3 — a b c d

1. Destroying equipment or play material
2. Untruthfulness (lying)
3. Imaginative lying
4. Cheating
5. Stealing
6. Profanity
7. Obscene notes, pictures, talk
8. Masturbation
9. Heterosexual activity (with opposite sex)
10. Disorderliness (violation of ward discipline)
11. Restlessness (overactivity) not chorea
12. Inattention
13. Lack of interest in play
14. Laziness
15. Unreliableness (irresponsible)
16. Disobedience
17. Impertinence (insubordination defiance)
18. Cruelty
19. Bullying
20. Quarrelsomeness
21. Annoying other children
22. Tattling
23. Stubbornness
24. Sullenness
25. Temper-tantrums
26. Impudence
27. Impoliteness, rudeness
28. Selfishness
29. Domineering, overbearing, dictatorial
30. Shyness, bashfulness
31. Sensitiveness
32. Unsociability, withdrawing
33. Overcritical of others
34. Thoughtlessness
35. Inquisitiveness, meddlesomeness
36. Silliness, "smartness," attracting attention
37. Unhappy, depressed, dissatisfied
38. Resentful
39. Nervousness
40. Fearfulness (easily frightened)
41. Enuresis (wetting self)
42. Specific fears
43. Dreaminess
44. Carelessness in personal appearance
45. Suspiciousness
46. Physical coward
47. Easily discouraged
48. Suggestible (accepts suggestion of anyone)
49. Disrespect for elders
50. Ungratefulness
51. Fault finding
52. Constant whining
53. Argues when corrected
54. Bad table manners
55. Demanding attention
56. Excessive modesty
57. Likes to play alone
58. Spends most of time reading
59. Asks questions continually
60. Unfairness

It was not feasible to have these questionnaires filled out by all the nurses in a given hospital at the same time, since they could not all simultaneously be relieved from duty. The questionnaire was therefore given to the nurses in groups, of whom it was requested that they consult no one before making their ratings.

The data called for through the questionnaire were kept in broad categorical terms, as it was thought unlikely that the nurses would be able to make finer distinctions. In tabulating the results of the ratings, totals for each group of nurses were made for each category in each item and then combined into grand totals for all the nurses. The total of the judgments in each category was assigned the relative percentage of all judgments for that item and the category in which the median fell was determined. By making use of the Kelley-Wood Table of the Normal Probability Integral, it was possible to determine at what point on the base line of the category the median fell. In this way could be determined not only within which of the four broad categories the median for each item fell, but also what percentage of the range covered by that category fell below the median judgment. The assumption is that the true distribution of degrees of frequency or seriousness follows the form of the normal frequency curve, with the respective medians occurring at different points on a scale range from zero to the highest possible degree. The items within each category were ranked in the order of frequency and seriousness by calculating the percentage of the category at which the median number of judgments fell.

Results of the questionnaire are summarized in Tables 1, 2, 3, and 4.

Table 1

Ratings by Nurses of the Frequency and Seriousness of the Problem Behavior of Children in Hospitals

	Frequency	Present seriousness	Future seriousness
Least	Heterosexual activity Cruelty Obscene notes, pictures, and talk	Destroying equipment or play material Dreaminess Spending most of time reading Imaginative lying	Asking questions continually Restlessness Spending most of time reading Excessive modesty Inquisitiveness
Most	Demanding attention Inquisitiveness or meddlesomeness Restlessness Silliness, smartness, attracting attention Bad table manners	Stealing Temper tantrums Heterosexual activity Cruelty Unhappiness	Stealing Impudence Heterosexual activity

Table 2

Comparison of Judgments of 57 Graduate Nurses and 171 Student Nurses on: I. Frequency of Occurrence of Behavior Problems; II. Present Seriousness; III. Future Seriousness

	Graduate Nurses (N: 57)	Student Nurses (N: 171)
I. Frequency		
Obscene notes, pictures, talk	b*	a
Restlessness (overactivity)	b	a
Thoughtlessness	c	b
Silliness, "smartness," attracting attention	b	a

* a: 50% or more judge problem as occurring in none of children;
b: " " " " " " " " a very small number;
c: " " " " " " " " about 1/2 of all children.

Table 2 - Continued

Comparison of Judgments of 53 Graduate Nurses and 171 Student Nurses on: I. Frequency of Occurrence of Behavior Problems; II. Present Seriousness; III. Future Seriousness

		Graduate Nurses (N: 53)	Student Nurses (N: 171)
II.	Present Seriousness		
	Heterosexual activity	d **	c
	Unreliableness (irresponsible)	b	c
	Quarrelsomeness	b	c
	Sullenness	b	c
	Impoliteness, rudeness	b	c
	Selfishness	b	c
	Unfairness	b	c
III.	Future Seriousness		
	Destroying equipment or play material	b	c
	Imaginative lying	b	c
	Inattention	b	c
	Lack of interest in play	b	c
	Annoying other children	b	c
	Tattling	b	c
	Stubbornness	b	c
	Impudence	b	c
	Impoliteness, rudeness	b	c
	Shyness, bashfulness	b	c
	Sensitiveness	b	c
	Overcritical of others	b	c
	Thoughtlessness	b	c
	Dreaminess	b	c
	Carelessness in personal appearance	b	c
	Ungratefulness	b	c
	Bad table manners	b	c
	Demanding attention	b	c

** b, rating indicates only slight importance; c, considerable importance; d, extremely grave importance.

Table 3

Comparison of Judgments of Nurses with High School Education and Judgments of Nurses with One Year or More of College Education on: I. Frequency; II. Present Seriousness; III. Future Seriousness

		High School (N: 124)	College (N: 100)
I.	Frequency		
	Obscene notes, pictures, talk	b	c
	Restlessness (overactivity) not chores	b	c
	Thoughtlessness	b	c
	Silliness, "smartness," attracting attention	b	c
	Bad table manners	b	c
	Demanding attention	b	c
II.	Present Seriousness		
	Profanity	c	b
	Quarrelsomeness	c	b
	Sullenness	c	b
	Impoliteness, rudeness	c	b
	Selfishness	c	b
	Resentfulness	c	b
	Easily discouraged	c	b
	Disrespect for elders	c	b
	Argues when corrected	c	b
	Bad table manners	c	b
III.	Future Seriousness		
	Untruthfulness (lying)	c	d
	Cheating	c	d
	Annoying other children	b	c
	Tattling	b	c
	Impudence	c	b
	Shyness, bashfulness	c	b
	Dreaminess	b	c
	Demanding attention	b	c

Table 4

Comparison of Judgments of Nurses with and without Nursery School Experience on: I. Frequency; II. Present Seriousness; III. Future Seriousness

	Nursery School (N: 63)	No Nursery School (N: 161)
I. Frequency		
Stealing	a	b
Obscene notes, pictures, talk	a	b
Domineering, overbearing, dictatorial	c	b
Sensitiveness	c	b
Thoughtlessness	c	b
Silliness, "smartness," attracting attention	c	b
Easily discouraged	c	b
Bad table manners	c	b
II. Present Seriousness		
Profanity	b	c
Masturbation	b	c
Impertinence (insubordination, defiance)	b	c
Quarrelsomeness	b	c
Annoying other children	b	c
Stubborness	b	c
Sullenness	b	c
Impoliteness, rudeness	b	c
Selfishness	b	c
Unsociability, withdrawing	b	c
Resentfulness	b	c
Nervousness	b	c
Fearfulness (easily frightened)	b	c
Physical coward	b	c
Easily discouraged	b	c
Disrespect for elders	b	c
Unfairness	b	c
III. Future Seriousness		
Heterosexual activity	c	d
Inattention	c	b
Annoying other children	c	b
Tattling	c	b
Temper tantrums	b	c
Impudence	b	c
Impoliteness, rudeness	b	c
Shyness, bashfulness	b	c
Dreaminess	c	b
Bad table manners	b	c

On all items not specifically referred to in the tables, the two groups were in agreement.

The following comparisons were also made, with results as indicated:

A. Judgments of present seriousness of problems by teachers[1] and by nurses: Nurses rated as of more present seriousness than teachers did, tattling, unsociability, fearfulness, stubbornness; depression, enuresis, and temper tantrums. Teachers rated as more serious carelessness in personal appearance, laziness, impudence, impoliteness, lack of interest, destroying equipment, impertinence, and obscenity.

B. Judgments of present seriousness of problems by parents[2] and by nurses. Nurses rated as more serious domineering, stubborness, being easily discouraged, constant whining, specific fears, depression, and enuresis. Parents rated as more serious than nurses problems associated with ungratefulness, suggestibility, physical cowardice, destructiveness, obscenity, unreliability, and masturbation.

The correlation between judgments of teachers and nurses is $.68 \pm .05$; that between judgments of parents and nurses is $.77 \pm .03$.

[1] In Wickman study.

[2] In Stogdill study.

C. Judgments of future seriousness of problems by mental hygienists and by nurses.

1. On the Wickman study, mental hygienists judged as more serious silliness, tattling, lack of interest in play, stubbornness, dreaminess, shyness, sullenness, sensitiveness, overcriticism, bullying, fearfulness, resentfulness, suspiciousness, and unsociability. Nurses of the present study rated as more serious disorderliness, disobedience, masturbation, impertinence, laziness, carelessness in personal appearance, obscenity, enuresis, heterosexual activity, cheating, untruthfulness, unreliability, temper tantrums, and stealing. The correlation is .34 ± .09.

2. On the Stogdill study, mental hygienists rated as more serious than nurses did problems associated with restlessness, tattling, demanding attention, liking to play alone, fault-finding, lack of interest in play, destructiveness, excessive modesty, nervousness, suspiciousness, constant whining, and specific fears. Nurses rated as more serious than mental hygienists did, bad table manners, carelessness in personal appearance, disrespect for elders, overcriticism, argumentativeness, impoliteness, laziness, domineering, masturbation, disobedience, and heterosexual activity. The correlation in this case was .56 ± .06.

D. Judgment of present seriousness of problems by mental hygienists and nurses.

1. On the Wickman study, mental hygienists rated as more serious suspiciousness, shyness, dreaminess, sensitiveness, suggestibility, unsociability, resentfulness, and overcriticism. Nurses rated as more serious than mental hygienists did, disobedience, disorderliness, masturbation, impertinence, heterosexual activity, enuresis, cheating, temper tantrums, lying, and stealing. The correlation is .40 ± .08.

1. On the Stogdill study, mental hygienists rated as more serious destructiveness, excessive modesty, suspiciousness, liking to play alone, lack of interest in play, unsociability, dreaminess, physical cowardice, resentfulness, irresponsibility, and specific fears. Nurses rated as more serious disrespectfulness, argumentativeness, impertinence, masturbation, disobedience, heterosexual activity, bad table manners, stubbornness, domineering, and impoliteness. The correlation here is .59 ± .06.

It was reasonable to suppose that nurses would be more likely to rank as least frequent those problem tendencies that came least often to their attention, and as least serious those that caused the smallest amount of disturbance in the ward. This assumption was borne out by the results. There are observable, however, certain notable divergences from this situation.

The main conclusions of this study may be summed up as follows:

1. Nurses rate as more frequent problems associated with an effort to get attention, and affecting only the welfare of the individual child. Transgressions against commonly accepted moral regulations are least frequently reported.

2. Problems that conflict with the conventional code, and introvert tendencies, are considered by nurses as most serious both at the time they occur and for the future welfare of the child.

3. Disciplinary offences are judged by nurses to be of considerable importance to the child's future welfare.

4. Attitudes of nurses toward behavior problems of children resemble most closely those of the parents studied by Stogdill.

5. Attitudes of nurses toward the future seriousness of children's behavior

problems resemble more closely those of the mental hygienists in the Stogdill study than those of the mental hygienists in the Wickman study.

6. Attitudes of nurses are more similar to attitudes of parents in the Stogdill study than to those of mental hygienists in the same study.

7. Few of the problems that parents and teachers meet are noted in as many as one-half the children of school age who are under hospital care.

8. Student nurses consider behavior that disturbs the peace of the ward, withdrawing tendencies, and demanding attention, as more serious than graduates do. Graduates rate heterosexual activity as very serious at the time of occurrence.

9. Nurses who have had only high school education believe the most frequent problems to be those in which the child is seeking for attention. The college group reports these problems, also those that interfere with their authority or with the happiness of others, as more serious for the present than the high school group does. The high school group sees greater seriousness for the future in problems that cause conflict with the integrity of the group.

10. There is a tendency for nurses without nursery school experience to rate more problems as serious for the present welfare of the child than those with nursery school experience do. These problems include withdrawing traits, conflicts with the conventional codes, and conflicts with authority. When considering the future welfare of the child, the nurses without nursery school experience consider opposition to authority, heterosexual activity, and shyness more serious.

11. If the attitudes of the mental hygienists in these studies are correct, training schools for nurses need to place more emphasis on mental hygiene in the curriculum.

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WISHES, FEARS, INTERESTS, AND IDENTIFICATIONS OF DELINQUENT BOYS [1]

GEORGE S. SPEER [2]

The delinquent child is one who is maladjusted, not only in terms of external objective behavior, but also in terms of his desires, aims, needs, and the direction of his interests. These desires and aims are the product of his environments, his experiences, his capacities, and his reactions to these factors. (2) The specific form of the delinquencies in which the individual expresses his inner turmoil, depends to some extent upon opportunity. It seems logical to suppose, however, that the largest factor in determining the type of delinquent act would be the sort of conflict and maladjustment which the individual is expressing.

If this assumption is correct, differences in type of delinquency should be matched by differences in the desires, wishes, ideals, and goals, of the individuals involved. The present paper reports an attempt to investigate this hypothesis.

As a part of the routine procedure in examing boys committed to the Berkshire Industrial Farm for various delinquencies, a questionnaire has been devised which is intended to reveal the direction of the individual's wishes, fears, identifications and interests. As Washburne (4) has indicated, when cooperation is carefully solicited there is very little tendency on the part of adolescent subjects to misrepresent their wishes. An effort has been made each time to elicit truthful replies to the different items on the questionnaire, and the replies were later discussed with each boy. Sincerity or untruthfulness are soon discovered by this procedure, and it is felt that the present replies represent sincere efforts to reveal the wishes, fears, and ideals of each of the subjects.

The population for this study consists of 100 boys, aged 11 to 15, with the mean age at 13.2. Forty-eight were committed to Berkshire Industrial Farm for truancy from school and absconding from home; fifty-two were committed for petty theft. The I.Q. ranges from 63 to 140, the mean being 97. There are no significant differences between the two groups, in age or intelligence.

WISHES

Goodenough (1) long ago recognized this significance of children's wishes in the diagnosis of the maladjustments, and as additional light on their attitude towards their problems. Our own question differs somewhat from hers, and has been made as simple and direct as possible without loss of meaning: "If by some power you could have your first three wishes granted, what would they be?"

The results are shown in Table 1. It is interesting to note that the wishes fall into four distinct groups, which are very similar to the four-fold classification of Thomas (3). The wish to be home, variously expressed, seems quite definitely to be a wish for security. The wishes classified here as the desire to do

[1] This study was conducted at the Berkshire Industrial Farm, Canaan, N.Y.

[2] From Children's Service League, Springfield, Illinois.

CHILD DEVELOPMENT, Vol. 8, No. 4 (December, 1937)

TABLE 1

Classification of Three Primary Wishes

Type of Wish	Group									
	Truant					Theft				
	Wishes			Total	%	Wishes			Total	%
	1	2	3			1	2	3		
To be Home	6	4	2	12	8.4	12	8	6	26	16.6
To Have Material Things	16	10	8	34	23.6	6	14	12	32	20.5
To be Someone	16	22	24	62	43.0	20	20	26	66	20.5
To do Things	10	12	18	36	25.0	20	20	26	66	42.4
Total	48	48	48	144	100.0	52	52	52	156	100.0

things, is very similar to the wish for new experience. The wish to be someone of importance seems likely to represent the desire for mastery. The wish to have material things corresponds less closely to Thomas' scheme, but is somewhat similar to his desire to attract others.

Not unexpectedly, the Truant group shows very little desire to be at home. Although there are more than twice as many expressions of the wish to be at home in the Theft group, this is a small part of the total expression of their wishes. Very little difference is found in the desire for material possessions, either in the frequency with which the wish is expressed, or in the type of thing that is wished for.

Significant differences in the wishes expressed are found in their attitude towards achievement and activity. The Truant group is definitely more interested in becoming a person of importance; the Theft group is much more interested in doing things. It seems possible that this is an expression of very real differences in attitude. The truants, who have run away from their difficulties in the past, would like to be someone of importance, but do not express any realization of the effort involved. The Theft group is concerned more with the immediate problems of activity which they feel would be congenial.

FEARS

It was felt that the expression of fears might suggest some of the underlying causes of the personality disorder and maladjustment. After some experimentation, the question was so phrased that even the most sensitive might answer it without loss of prestige. "Even though you are not really afraid, write the three things of which you are most afraid." When some subjects balked at this form, they were requested to write the things which they would be afraid of if they were afraid of anything. Even this did not elicit responses from many of the subjects, and a category of "no fear" had to be included, though it is felt that in the majority of cases this refusal to name the fears was in itself an expression of fear: fear of ridicule or contempt on the part of the examiner. This feeling seems supported by the division of the boys into the two groups. The Truant group has three times the number in the Theft group who refuse to express fears, and also the greater number of those who express a fear of being injured.

If the fear of animals, and the fear of being hurt, are considered together, as seems logical, the differences between the groups become more apparent. The Theft group expresses a fear of its own probable future behavior, generally expressed as a fear of personal failure. The differences in the other fears are

TABLE 2

Classification of Three Primary Fears

Type of Fear	GROUP									
	Truant					Theft				
	Fears			Total	%	Fears			Total	%
	1	2	3			1	2	3		
Of Animals	24	16	20	60	41.6	16	14	2	32	20.6
Of Being Hurt	10	12	6	28	19.4	2	4	7	13	8.3
Of Own Behavior	0	4	2	6	4.8	16	18	19	53	33.9
Of Natural Forces	2	2	0	4	3.3	8	2	2	12	7.6
Of Illness and Death	2	2	6	10	6.6	4	2	8	14	8.9
Uncongenial Occupation	4	2	2	8	5.6	2	2	2	6	3.8
Miscellaneous	0	2	2	4	3.3	4	3	8	18	11.7
No Fear	6	8	10	24	15.3	0	4	4	8	5.1
Total	48	48	48	144	99.9	52	52	52	156	99.9

not statistically significant.[1]

POSITIVE IDENTIFICATION

Who is the ideal of the delinquent boy? With whom would he change places if he could? To investigate this aspect of the mental life of this group, they were asked, "If you could be like anyone, real or imaginary, living or dead, whom you have read of, heard of, or imagined, whom would you like most to be like? Why?" The results are presented in Table 3.

TABLE 3

Classification of Positive Identifications

Type of Identification	GROUP			
	Truant		Theft	
	Number	%	Number	%
Personal Characteristics	26	54.2	12	23.0
Fame and Reputation	8	16.6	0	0.0
Occupation	12	25.0	36	69.2
None	2	4.1	4	7.7
Total	48	99.9	52	99.9

Inspection of the results indicated that it is the second part of this question which is the more important. Many chose the same historical or literary figure, but for quite different reasons. Washington, for example, was selected because "he was a good man", "because he was a famous president", "because he was a great general and won a lot of wars". For this reason the results are presented as indicating the reason for identifying with the individual's choice, rather than classifying the choices themselves.

Occupational reasons for identification are outstanding in the Theft group, nearly three-fourths of the group giving this reason. None of the group mentions fame or reputation as a reason, which seems equally significant. This group seems consistently interested in doing things, in forms of behavior and activity. The Truant group, on the other hand, is equally consistent, giving as reasons for its choice the personal characteristics and the fame and reputation

[1] It is interesting that only two boys expressed a fear of persons. One was afraid of his mother, the other of foreigners.

of the individuals. This group seems much less interested in working, and much more interested in being a well-known or admired person.

NEGATIVE IDENTIFICATION

The reverse of the third question was also included, to find not only those whom the subject would like to be like, but whom he would not like to be like. The question was, "If you had to choose someone to be like, who is the last person you would choose? Why?" The results are tabulated in Table 4.

TABLE 4

Classification of Negative Identifications

Type of Classification	Group			
	Truant		Theft	
	Number	%	Number	%
Occupation	12	25.0	7	13.4
Personal Qualities	8	16.6	32	61.5
Criminal Behavior	26	54.1	11	21.1
No Reply	2	4.1	2	3.8
Total	48	99.8	52	99.8

On this question the attitudes of the groups are reversed. The Theft group shows a decided interest in the personal characteristics of the individuals they dislike, while the Truant group displays very little interest in these qualities. The latter group reveals a very decided interest in the behavior of the individuals they dislike. Such remarks as "He steals", "He kidnapped", "He murdered", indicate a repulsion from such activities. The Theft group evidences little interest in this sort of behavior. The differences in their feeling concerning occupational dislikes are not statistically significant.

DESIRED ACTIVITIES

Are there significant differences in the activities which would be chosen by these boys, if their choice were free? In order to throw some light on this aspect of the direction of their interests, each boy was asked, "Of all the possible ways of spending your time you have ever heard of, read of, or imagined, which would you like best to do? Why?" The results are presented in Table 5.

TABLE 5

Classification of Desired Activities

Type of Activity	Group			
	Truant		Theft	
	Number	%	Number	%
Occupation or Profession	9	18.7	33	63.3
Recreation other than Games	8	16.7	12	23.1
Adventure	8	16.7	0	0.0
Games and Sports	23	47.8	7	13.5
Total	48	99.9	52	99.9

Again the Theft group shows a very decided and significant interest in occupation, while the Truant group displays very little interest in work, and a definite

interest in sports, adventure, and other forms of recreation. It is interesting that not one of the Theft group showed an interest in adventure. Whether the interest in adventure shown by the Truant group is responsible for the truancy, or is a product of it, is a problem still to be investigated. Certainly the majority of these boys have had adventurous experiences during their truancies.

UNDESIRED ACTIVITIES

If there are important differences in the desired activities of these groups, those activities which are undesired and disliked should also reflect their difference in attitude and viewpoint. Question 5B was, "Which would you like least? Why?" The results are presented in Table 6.

Again, there are decided differences between the two groups. Statistically, none of these differences are truly significant, but when they are considered in the light of the previous results, it is felt they are important. These results need perhaps more interpretation than the former tables.

Apparently there is no difference between the Truant and Theft groups in their dislike for work or particular occupations. However, the reason for the expressed dislike indicates a sharp difference in attitude which is difficult to express graphically. The Truant group does not want to work; the Theft group does not want particular types of work. In other words, the former group dislikes work in general, the latter group is still concerned with finding a congenial type of work in which achievement is possible.

This difference in attitude is consistently expressed in another way. The Theft group definitely dislikes doing nothing, though the Truant group has little antipathy towards inactivity. In the field of recreation, both groups express

TABLE 6

Classification of Undesired Activities

Type of Activity	Group			
	Truant		Theft	
	Number	%	Number	%
Work or Occupation	17	35.5	18	34.6
Recreation	21	43.7	4	7.6
Idleness	6	12.4	25	48.1
Miscellaneous	4	8.3	5	9.6
Total	48	99.9	52	99.9

definite dislikes for particular forms of recreation or games. The Truant group, however, much more frequently expresses a dislike of particular forms of recreation. Considered with the activities desired, as shown in Table 5, this would appear to indicate a greater concern with recreation and sports on the part of the Truant group.

SUMMARY AND CONCLUSIONS

One hundred adolescent delinquent boys, who had been committed to the Berkshire Industrial Farm, 48 for truancy, 52 for petty theft, were individually examined in respect to their wishes, fears, interests, and identification with heroic or famous figures. Significant differences were found between these groups, which it is felt are important in explaining the particular type of delinquency of which the boys are guilty.

It is concluded that, of this group:

1. The Truant group is much more interested in becoming a person of importance; the Theft group is much more interested in congenial activity.

2. The Theft group is afraid of failure, the Truant group of personal injury.

3. The Theft group identifies itself with heroes or famous people because of their activity or occupation; the Truant group identifies on the basis of the personal characteristics and fame of the individual.

4. The Theft group negatively identifies on the basis of personal characteristics; the Truant group negatively identifies on the basis of activity or behavior.

5. The Truant group would most like to spend its time in sports, adventure, and recreation; the Theft group prefers work.

6. The Truant group dislikes work in general; the Theft group dislikes particular types of work.

7. The Theft group definitely dislikes being idle; the Truant group expresses little dislike for complete inactivity.

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EFFECT OF PICTURES ON RECALL OF STORIES TOLD ORALLY[1]

DOROTHY TILDEN SPOERL

PURPOSE

The purpose of this study was to determine the effect of the presence of pictures on the amount of a story that a group of children could recall; to determine whether they would remember the story more clearly when accompanied by pictures, or whether the pictures, by their own intrinsic story-telling power, would detract from the oral story.

It was further hoped that it would be possible to determine whether any confusions were caused by the pictures, or if, on the other hand, they would tend to clarify points which would otherwise be confusing.

METHOD

In the preliminary study an attempt was made to secure immediate recall on the part of the children; in the main body of the study recall was delayed.

The group of children used in the study was an "auxiliary class" of a large city elementary school. With two exceptions the children were of Italian parentage and came from Italian-speaking homes. The intelligence quotients of the group (as measured by the tests used in the city psychological laboratory) ranged from 52 to 98. For two of the children it was not possible to obtain the city score.

The children were also given the Goodenough Drawing Test, by which the intelligence quotients ranged from 51 to 113. In the case of the child securing 113, it seems likely that the city score is more accurate. In the other cases the comparison between the two scores showed a surprising similarity, giving a correlation of +.73. Seven of the group were boys and eleven were girls. The chronological ages ranged from 6;9 to 14 years. The Goodenough mental age range was from 4;9 to 10;9.

The subjects were divided into three groups as follows:

Group	Number	Average I.Q.	Average M.A.
I	5	71.8	5;10
II	8	78.	7;4
III	5	83.	8;4

In the study of immediate recall the two stories were told to the children in groups, then repeated to the examiner, who took the story in shorthand. As a break between the telling and retelling, each child was asked to draw anything in the story which he thought was interesting.

In the study of delayed recall the story was told to the class as a whole, one story on each of two consecutive days. One week later the children, divided into groups, repeated the story to the examiner as in the immediate recall study.

[1] The author is under obligation to the school department of the Springfield, Massachusetts Public Schools, to Mr. Frank Doane, principal of the Howard Street School, and to Miss Minnie Estabrooks, for cooperation in making this experiment possible.

STORIES USED

In the study of immediate recall different material was used with groups I and II than with group III. Group I and group II had Elsa Beskow's PELLE'S NEW SUIT told with pictures, and Marjory Flack's ASK MR. BEAR told without pictures. Group III (who knew one of these stories) had two chapters of Elizabeth Orton Jones' RAGMAN OF PARIS told without pictures, and two other chapters told with pictures.

In the study of delayed recall the same stories were used for all groups. In each contrasted set (that is, the story with and the story without pictures), the stories were by the same author. This was done to have the stories as similar in quality as possible. Stories used were Marjory Flack's WAIT FOR WILLIAM and WHAT TO DO ABOUT MOLLY, and Maj Lindman's SNIPP, SNAPP, SNURR AND THE BUTTERED BREAD, and SNIPP, SNAPP, SNURR AND THE RED SHOES.

RESULTS

The following table will show the results of the study. In each case the number of items in each story was listed, and the stories as retold by the children were checked against these lists. The percentage refers to the percent of items in the original story recalled by the children.

Immediate Recall

Group	With Picture		Without Picture	
I	Pelle's New Suit	48%	Ask Mr. Bear	67%
II	Pelle's New Suit	78%	Ask Mr. Bear	82%
III	Ragman of Paris	23%	Ragman of Paris	36%

If all the percentages for stories with pictures are averaged and compared with all the percentages for stories without pictures, we find in the case of immediate recall with pictures 49.6% retention, and in immediate recall without pictures, 61.6%.

Delayed Recall

Group	With Picture		Without Picture	
I	Buttered Bread	37%	The Red Shoes	22%
I	Wait for William	27%	What to Do About Molly	27%
II	Buttered Bread	66%	The Red Shoes	57%
II	Wait for William	45%	What to Do About Molly	40%
III	Buttered Bread	59%	The Red Shoes	60%
III	Wait for William	43%	What to Do About Molly	35%

For Group I there is a tie in the case of the two Flack stories, each having a 27% recall. In Group III the two Lindman stories have a difference of only 1%. However, if the average for all the stories is taken we have the following group averages:

Group I: with pictures, 32% without pictures, 24.5%
Group II: with pictures, 55.5% without pictures, 48.5%
Group III: with pictures, 51% without pictures, 47.5%

The total average for the three groups would be: Percent recalled when there were pictures, 49.1%; and percent recalled without pictures, 40.1%. It will be noted that these results are the reverse of those in the study of immediate recall.

Errors of Reproduction

The errors made in retelling the stories do not seem important. In the story about the RED SHOES, Group II said that the shoes in the story had red "ribbon" rather than "lining." In the story about ASK MR. BEAR, the same group could not understand the word "feathers," calling it "leathers" and "weathers;" the word obviously had no meaning.

In the story of PELLE'S NEW SUIT both groups I and II were confused by the words "weave," "card," "spin," generally substituting the word "sew." They also called "dye" "paint," and were occasionally confused as to whether the story had mentioned cows or pigs (both being in it in different places.)

Confusions

The confusions seemed more significant. Group I was confused as to the process of butter-making, maintaining that Mother made the butter from grass. A study of the pictures shows the intermediate picture of milking the cow to be less vivid, especially as regards participation by the story-children, than the one where they are haying, or Mother is churning. This may explain the confusion.

Groups II and III were confused in the story of WHAT TO DO ABOUT MOLLY, believing she was tied to a tree rather than to a wharf. It seems clear that they did not understand the meaning of the word "wharf."

Additions

Only one addition was made in the case of a story without pictures. In WHAT TO DO ABOUT MOLLY the children ended the story with: "Father said, 'This is a good dinner.'"

Four additions were made in the story WAIT FOR WILLIAM. One child said: "There was a balloon man. She wanted a balloon." (There is none in the story, but it is in a picture.) When the story-children say "Look at William," one child substituted: "Who put you up there?" (He is high on the elephant's back in the picture.) They also said: "They pushed him home on his scooter;" whereas he rides it himself. And they ended with: "Mother, I went to the circus." It seems obvious that the first two additions were caused by the pictures. In PELLE'S NEW SUIT they end the story (Group I) with the phrase: "He went to church." The story mentions that it is Sunday, but the final picture shows everyone in his Sunday best. There is no church in it, however.

CONCLUSIONS

Although this is a preliminary study and should be repeated both in another "auxiliary class" and in a class of normal children of similar mental age, it seems reasonable to make the following tentative conclusions:

1. The pictures used with a story are vivid enough to interfere with the

immediate recall of the story.

2. In the case of delayed recall, the stories which were accompanied by pictures are more vividly and accurately remembered.

3. A study of confusions would lead to the conclusion that pictures can do away with errors by defining unknown words (as would have been true of the wharf in WHAT TO DO ABOUT MOLLY), but will not do so unless the items are pointed out when the story is told, as is shown by the confusions about "carding," "weaving," etc. in PELLE'S NEW SUIT, which are illustrated in the picture. In other words, the pictures will not clear confusion by their own presence; the teacher or story-teller must point out some of the details.

4. In delayed recall the memory of particularly vivid pictures may serve to cover intermediate steps (this perhaps would not be as true for normal children), as in the case of the "butter is made of grass" confusion on the part of the children in the story SNIPP, SNAPP, SNURR AND THE BUTTERED BREAD.

COMMENTS UPON J. M. SMITH'S WORK, "THE RELATIVE BRIGHTNESS VALUES OF THREE HUES FOR NEWBORN INFANTS"

ALBRECHT PEIPER [1]

Translated by

KARL C. PRATT

In her work Smith[2] criticizes my researches "Über die Helligkeits- und Farbenempfindungen der Frühgeburten"[3]. She reproaches me with "The small number of experiments and the inconsistency between his data and some of his conclusions from them."

The most important objection is directed against my sentences: "Upon dark-adaptation the relative brightness-value of colors is shifted toward the violet end. The Purkinje phenomenon is thus already clearly demonstrated at this stage of development." Against this Smith makes the following objection: "The curves showing the relative brightness of the four colors for the two subjects under the two conditions are presented in Figure 3. It will be seen immediately that the point of highest brightness after dark-adaptation for both infants is at the red. The shift toward increased brightness at the blue end, asserted to occur by Peiper, is not apparent in his data or curves. Neither is the highest brightness for the infants and for the adult at the same point after dark-adaptation. The characteristic of the Purkinje phenomenon is that the relative brightnesses of blue and green are increased by dark-adaptation, while those of red and yellow are decreased. Peiper's own results fail to prove the Purkinje phenomenon at this stage of development. ..." (p. 100)

To this I make the following observation. On page 15 of my work I had described the effect of dark-adaptation as follows: "As a glance at the curves shows, the stimulus relation of the colored glasses to one another[4] has completely altered. Red and yellow have decreased markedly while green and blue have maintained the same position with respect to white. One thus sees basically the same behavior in the premature infant as in the adult, a typical Purkinje phenomenon."

The Purkinje phenomenon consists in the fact that in dark-adaptation the relative brightness value of colors to one another is shifted. Red thereby becomes relatively darker than blue or -- what is the same thing -- blue becomes relatively brighter than red. If, for example, a given red and a given blue are selected and under illumination and light-adaptation the red appears brighter than the blue, then, upon lowered illumination and under dark-adaptation there will be a change in the opposing brightness-values under conditions so rigorous that now the red appears darker than the blue (or the blue brighter than the red).

[1] From Wuppertal, Germany.

[2] Smith, Josephine: The Relative Brightness Values of Three Hues for Newborn Infants. [In] Wenger, M. A., Smith, Josephine, Hazard, Charles, and Irwin, Orvis C.: Studies in Infant Behavior III. Univ. Iowa Stud., Stud. in Child Welfare, 1936, 12, Pp. 207 (p. 91-140).

[3] Archiv für Kinderheilkunde, 1927, 80, 1-20.

[4] In the original. (Not emphasized in print)

Thus by relative brightness-value of colors in the Purkinje phenomenon one means the relative brightness-value of colors to one another, and not, as Smith in her criticism seems to assume, the relative brightness-value of colors with respect to white light. That the relative brightness-value of colors to one another is most distinctly shifted, follows from the curves and figures which Smith (p. 101) cites as counterevidence from my work. In the case of Elfriede, for example, yellow under light-adaptation is about four times as bright as blue, under dark-adaptation on the other hand it is only slightly brighter. In the case of Michel, yellow, under light adaptation, is exactly four times as bright as blue, under dark-adaptation even somewhat darker. With respect to red and blue the relative brightness-value of the colors to one another has been shifted in the same direction. Therefore the Purkinje phenomenon is demonstrated in those curves and figures.

Smith has further uttered the reproach that I carried out too limited a number of investigations. I therefore call attention to an important difference between our two works: In my work every single child in every single investigation behaved basically as every other child. Therefore I did not pursue the studies further. Smith, on the other hand, reports upon average results from a larger number of children studied. If I understand Smith (p. 125) correctly, in the comparison of the sexes the averages of all the investigations have indeed behaved differently, but individually many boys have reacted like girls and conversely many girls have behaved like boys. But if, according to Smith, newborn boys are totally color-blind and girls partially color-blind, then the reactivity of every single boy must differ from that of every single girl.

Without criticizing Smith's work in detail I should like to state another consideration. The adaptation-state of the eye, which influences the brightness-value of colors, is not changed quite so rapidly upon a change in illumination. I therefore brought the children into the dark-room at least one hour prior to studying them under dark-adaptation. Smith, on the other hand, introduced dark-intervals of approximately five minutes between the different color experiments (which lasted five minutes) and compared the motility during the five minute experiments. During the dark-experiment the child's eye adapts to the dark, during the color-experiment it adapts to the light. But we cannot determine the brightness-value for an eye while its adaptation-state is changing; for the brightness-value depends upon the adaptation-state.

Upon this occasion I refer to my article "Über das Unterscheidungsvermögen des Kleinkindes."[5] While I established conditioned reflexes to colors, and thereby took into consideration their relative brightness-value, I was able to demonstrate that red, yellow, green and blue could be discriminated in about 30 degrees of brightness at the beginning of the third year of life; that therefore the child at this time cannot be totally color-blind. As I showed further, there exists at this time no red-green or blue-yellow blindness. With the aid of conditioned reflexes I succeeded in demonstrating structures (reacting) to pure colors.

[5] Jahrbuch für Kinderheilkunde, 1927, 117, 150.

REPLY TO PEIPER[1]

JOSEPHINE M. SMITH

Professor Peiper has invited me to comment upon his reply to an analysis which I made of his data on the dark adaptation of the eyes of premature infants, and to his criticism of my work. I wish to thank him for his courtesy and hope that the accompanying remarks may be taken in the same friendly spirit of cooperation toward the solution of the problem which Professor Peiper has shown.

Peiper states in his reply, "The Purkinje phenomenon consists in the fact that in dark-adaptation the relative brightness value of colors to one another is shifted. Red thereby becomes relatively darker than blue or -- what is the same thing -- blue becomes relatively brighter than red." (p. 299) With both statements I am in accord. Moreover, Peiper's data on the premature furnish an illustration of the first. The following tabulation gives the average values of Peiper's experiments (relative brightness expressed in per cent):

		Relative Brightness Value			
		Blue	Green	Yellow	Red
Elfriede	Light-adapted	5.6	1.7	22.7	15.3
	Dark-adapted	2.8	1.85	3.5	4.8
Michel	Light-adapted	8.5	4.0	32.0	22.7
	Dark-adapted	7.8	7.8	6.6	10.0

In light-adaptation the values for red and yellow are much larger than for blue and green, while in dark-adaptation the values for the hues are very similar.

However, the second statement above does not seem to be borne out by Peiper's data. In light-adaptation the red had a higher value than the blue and green; and in dark-adaptation according to Peiper's data the red continues to have a higher stimulus value than do the blue and green. The shift to the short end of the spectrum has not been demonstrated in these data. If Peiper means by Purkinje phenomenon that after dark-adaptation the brightness value of red, in comparison to that of blue, is diminished, I grant that his data support his conclusion. But if by Purkinje phenomenon he means that after dark-adaptation red has a lesser stimulus value than have blue and green, then I must again refer the question to his data.

Peiper states that "If, for example, a given red and a given blue are selected and under illumination and light-adaptation the red appears brighter than the blue, then, upon lowered illumination and under dark-adaptation there will be a change in the opposing brightness-values under conditions so rigorous that now the red appears darker than the blue (or the blue brighter than the red)." This change is what I had considered to constitute the Purkinje phenomenon. However, by referring to the tabulation above, which gives the average values for the two subjects that Peiper tested under both dark- and light-adaptation, it will be seen that under dark-adaptation the relative brightness value given is

[1] Comments upon J. M. Smith's Work, "The Relative Brightness Values of Three Hues for New-born Infants." (See previous article in this Journal).

less for blue than for red.

Peiper states, "That the relative brightness-value of colors to one another is most distinctly shifted, follows from the curves and figures which Smith [2] (p. 101) cites as counter-evidence from my work." This is undeniably true. Peiper has beyond question established that the relative brightness-value of the blue-green to the yellow-red ends of the spectrum do change from light- to dark-adaptation. Perhaps this fact may be interpreted to mean that the Purkinje phenomenon is present in prematures, and that with continued dark-adaptation the red and yellow values would drop further until they are less than the blue and green values.

Peiper, in his original report,[3] has himself suggested an approach to the question which if strictly carried out should clarify the issue. He states that his dark adaptation experiment "was designed to determine whether in this case the eye of the premature behaves like that of the adult; that is, whether the Purkinje phenomenon is already demonstrable." The assumption here is that if premature and adult eyes under the condition of dark-adaptation react similarly, the Purkinje phenomenon must be present in the premature. If Peiper's graphs for the premature are placed in juxtaposition with those of the adult, their similarity can be compared. That for the light-adapted eye is striking. The following graphs, in which the dotted line represents the values for the adult and the solid line those for the premature in the five experiments, make possible the comparison. The last two graphs, which give the average values for the two infants, Elfrieda and Michel, indicate the results as a whole and do not show the expected similarity to the adult eye values. As brought out above, those graphs show that the higher values for the dark-adapted premature eye are for the red and yellow, not for the green and blue as the Purkinje phenomenon demands.

The difference between Peiper's and my investigations to which he calls attention is perhaps an instance of a fundamental German-American procedure difference. It seems part of the German inheritance to select a small group of subjects and exhaust the possibilities of the group; and equally characteristic of the American to take a large group and apply statistical controls. I should defend my use of a large number of infants, and of treating the statistical average rather than the real individual, by saying that such a treatment allows for individual variation. I do not expect every boy infant to act differently from every girl infant. The data on ages are inexact; some babies were undoubtedly slightly premature while others had been carried beyond term. We know nothing of the inheritance of the infants, whether any had intellectual or visual defects or talents. I depend upon the statistical averages and treatments of differences to iron out such individual variations, and to indicate whether or not the average girl infant differs from the boy infant.

With respect to the condition of adaptivity of the eye, Peiper is of course entirely correct in contending that my five-minute dark period did not achieve complete dark-adaptation. My purpose in the use of the short dark period was not to secure complete dark-adaptation, but (1) to insure the same state of adaptiv-

[2] Smith, Josephine M.: The Relative Brightness Values of Three Hues for Newborn Infants. Studies in Infant Behavior III. (In) Wenger, M. A., Smith, Josephine, Hazard, Charles, and Irwin, Orvis C., Univ. of Iowa Stud., Stud. in Child Welfare, 1936, 12. Pp. 207 (p. 91-140).

[3] Peiper, Albrecht: Über die Helligkeits- und Farbenempfindungen der Frühgeburten. Arch. f. Kinderheil. 1927, 80, 1-20.

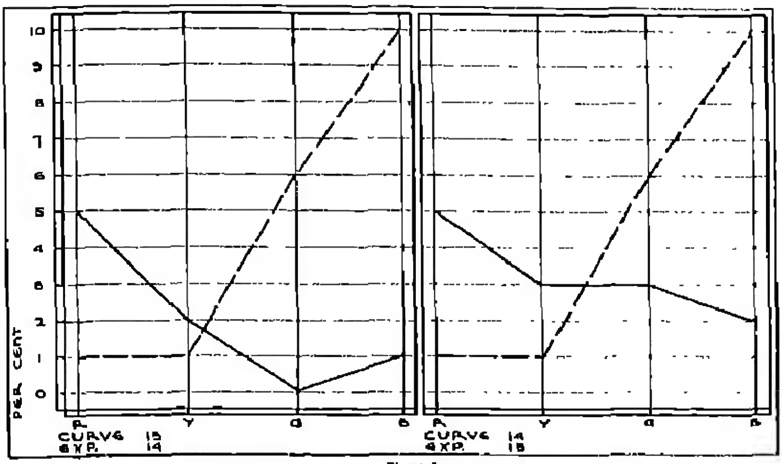

Figure 1

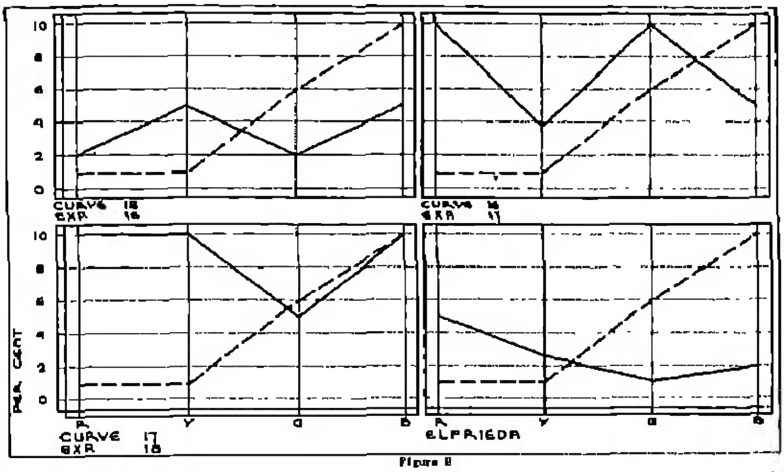

Figure 2

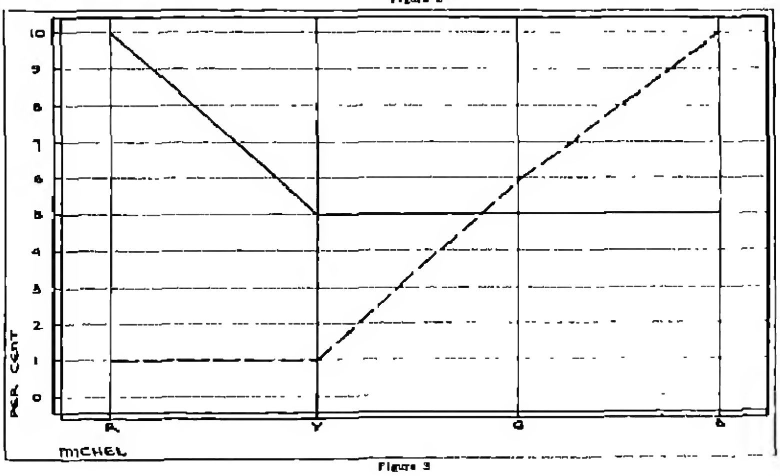

Figure 3

ity in all subjects and (2) to have it for use as a control (non-light-stimulating) period. Of course, after 20 seconds of light stimulation, the subjects' eyes were light-adapted, as the eyes of Peiper's infants must also have been after the first 20 seconds of his working period.

Peiper and I both sought in our studies to answer the question, Does the new-born infant possess hue-sensitivity? Also we both recognized the importance of the fact that the relative brightnesses of hues is not the same for color-seeing and for color-blind persons, a fact too often overlooked in color work. Therefore, Peiper's question became, "Do the relative brightness values of hues for the infant change after dark- and after light-adaptation?" and my question became, "What are the relative brightness values of hues for the infant under constant (light-adapted) conditions?" Peiper's criterion was the eliciting of the neck-reflex, and mine the inhibition of activity. So far our paths are similar.

However, the results of the two experiments are not alike. Peiper finds that red and yellow are less bright to the premature after dark- than after light-adaptation, and interprets this to indicate the presence of the Purkinje phenomenon.[4] My study found that blue and green inhibited activity (using activity in darkness as the comparison) 50 or almost 50 per cent, while red inhibited activity less than 25 per cent. Moreover, a sex difference was found. For the girl infants the percentages of inhibition exerted by blue, green, and red illumination were respectively 61, 42, and 47. This seems to indicate that the girls were stimulated by the blue, green and red lights; or that they probably possess color vision. But for the boys the percentages of inhibition exerted by blue, green, and red illumination were respectively 44, 22, and 6. There was not a statistically reliable difference between activity under red light and in darkness, indicating that the boys were not affected by the red. Apparently they do respond to blue. These facts lead to the tentative conclusion that the boys are at least partially color blind.

The intricate field of color vision has been approached by two different investigators in two different manners. The results of these experiments have led to contradictory conclusions. It is hoped that further research may lead to interpretations which will encompass both types of endeavor.

[4] This is the point of disagreement discussed above. Does the fact that red and yellow are duller after dark- than after light-adaptation demonstrate the presence of the Purkinje, or is it necessary that under dark-adaptation yellow and red be duller than blue and green?

FREQUENCY OF CHOICE OF PLAY MATERIALS BY PRE-SCHOOL CHILDREN

MARION SILL McDOWELL[1]

There is considerable need for more information than is now available on the suitability of various toys and other play materials to the requirements of children of pre-school age. It is recognized that the child of this age group is forming habits of thinking and acting which will remain with him for a lifetime, and that his play, which is his chief daily activity, should therefore be directed well.

Various requisites of play materials are generally regarded as desirable, namely; developing large and small muscles in the child, training him in the recognition of color, form, and size, giving him certain manual skills, stimulating his imagination, and developing in him a sense of order. Although these objectives are accepted by most persons in the field, little actual information has been accumulated about the suitability of the different types of play materials on the market to the needs mentioned, and few data have been collected on the child's own likes and dislikes of these materials, if he is given freedom of choice in selecting the objects with which he plays.

The investigation described in this paper was undertaken in order to find out the interests of two and three-year old boys and girls enrolled in the Nursery School at The Pennsylvania State College, in the play materials at their disposal during spontaneous play periods at the school, this being the first in a series of studies carried on by the author and co-workers on problems closely related to the topic under discussion. Alice S. Stratton, Graduate Assistant in the Nursery School, is especially deserving of mention for her cooperation in carrying out this study and in collecting the data presented herewith.

Play Materials

The play materials used in this study were the following: (1) doll corner; (2) dolls; (3) picture books; (4) clay; (5) paints; (6) blackboard; (7) beads; (8) large blocks; (9) medium blocks; (10) small blocks; (11) dishes; (12) flower tile; (13) concentric figures; (14) nest of eggs; (15) nest of dolls; (16) nest of rings; (17) nest of trays; (18) puzzles; (19) pyramid; (20) wooden animals; (21) ball; (22) pull toy; (23) cars; (24) trains; (25) truck; (26) wagon; (27) wheel barrow; (28) large pegboard; (29) small pegboard; (30) hammer toy; (31) seesaw; and (32) slide.

The doll corner included a tea table, a set of dishes, several dolls, doll clothes, a doll bed and bed clothes, a doll carriage, and a rocking chair.

Subjects

The subjects used in the study were twenty children between 24 and 48 months, nine being boys and eleven girls. All of the children were from families of about the same income level, nine boys and eight girls being from professors' families, two girls from merchants' families, and one girl from a minister's

[1] From The Pennsylvania State College. The author wishes to acknowledge and express her appreciation to Dr. Pauline Beery Mack for the reading and criticism of the manuscript and assistance in mathematical treatment.

CHILD DEVELOPMENT, Vol. 8, No. 4 (December, 1937)

family.

Before beginning the study, the subjects were tested on the Merrill-Palmer intelligence scale to compare their mental ages (according to this method of testing) with their respective chronological ages. It was found that the mental ages of the children ranged from 29 to 61 months, eighteen children having mental ages higher than their chronological ages, one child having a mental age and a chronological age the same, and one being slightly lower in mental than in chronological age.

The study was conducted while the children were given about one hour of spontaneous indoor play each day during the school year. Records were taken of each child's activities during fifteen observation hours, these being interspersed throughout the duration of the study. One person served as observer for one child throughout one observation period.

Observations were made on the following points:

(1) frequency of choice of materials;
(2) attention span;
(3) use of materials;

Observers

The observers were senior or graduate women students in Home Economics at The Pennsylvania State College, who had taken or were taking the Nursery School practice course. These persons were trained for the work by observing and recording the activities of children whom the author was simultaneously observing. This training was continued with each student until she was capable of turning in records closely corresponding with those of the author.

Directions for Observers

The directions given below were followed by each observer assisting in the study:

Remain sufficiently close to the child to be able to hear his language.

If a child gets into a situation, such as requiring help, such help should be given. Offer no help, however, unless such a situation arises.

If an unavoidable interruption occurs while an observation is in progress -- such as, toileting, washing hands, or undergoing a health examination -- record the number of minutes consumed during such interruptions, and increase the observation time by a like amount. The reason for all interruptions should be noted.

If a child under observation asks to have a story read to him, do so; but deduct the time from the observation period as mentioned above, such an activity not being regarded as child activity. If a child looks at a book alone, however, the time thus spent should be included in the record.

If a child asks to have music played, tell him that this will be provided later in the day. No music shall be played, however, until all observations for the day are completed.

If the observer is obliged to direct some social situation, this should be indicated on the record sheet. If any interference is given to a child under observation, this should likewise be noted. As much information concerning situations of this kind should be entered in the record as time permits.

No activity should be interrupted until it is voluntarily completed by the child.

If a child plays with an individual article from the doll corner without

regard for other articles in the corner, this should be listed under the individual item. If he uses two or more articles from the doll corner at one time, this should be entered as "doll corner".

Recording Sheet

The following Recording Sheet was used, explanations being given here for the type of record desired under each separate item.

Toy or Material. - Give name of toy or other play material selected by the child stating which specific article was used so that one article, such as a puzzle, or a set of blocks, may be distinguished from other articles of the same name.

Time. - Record the time when the activity was begun and ended.

Manipulations. - Record whether or not the play material was handled constructively, or with no idea of using it properly.

Uses. - Record the use made of the material, such as building a "tower" with blocks. If a puzzle was used, record what proportion of the pieces was used, and at what point the child considered the puzzle completed. Make similar records about other materials.

Return. - Check here if child returned material without the suggestion of an adult, at the end of his play with it.

Not Returned. - Check here if the material was not returned to its place.

Language. - As far as possible, quote the language of a child, whenever this has a bearing on his play activities. If he talks to other children, note the ones to whom he talks.

Imitation. - If a child follows a suggestion made by another child, or if he imitates another child note should be made of this.

Results Observed

In general approximately the same result was obtained when a child's interest in a certain toy or other play material was calculated from the attention span (the over-all time during which a child was engaged with the material at any one time) and when it was determined from the frequency with which this play material was chosen. For purposes of the present study, the frequency of choice is used as an index for estimating the popularity of a toy, a critical comparison of the attention span and the frequency of choice of the same toy by the same child being reserved for a future paper.

The comparative frequency of choice of the various play materials by boys and girls of the two age groups is shown graphically in Figure 1. On the right of the figure, the actual frequencies are used without regard for percentage of the total. On the left of the figure the frequencies are re-graphed on the basis of the percentage of the total cases in which a certain play material was selected. In both parts of the figure, the total choices, and the choices by boys and by girls of the three-year and the two-year groups are given. It will be noted from this figure that the differences between the play material choices made by the two sexes within the ages studied are considerably less than is usually supposed, there being no significant differences in the case of most of the play materials.

In Table 1 the play materials are grouped according to the type of activities involved in their use, some of them being similar in many respects. The follow-

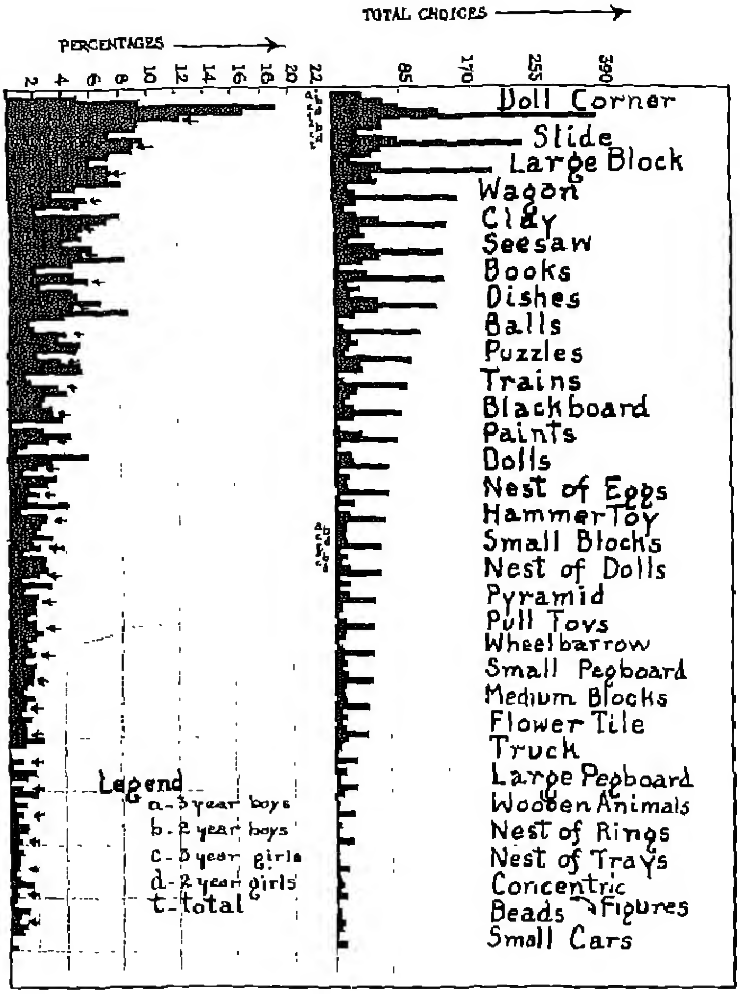

Figure 1. (Right) Actual frequencies of choice, based on a total of 2659 choices, including 685 choices for three-year old boys, 693 for two-year old boys, 440 for three-year old girls, and 841 for two-year old girls.

Figure 1. (Left) Percentage of the total cases in which a toy was selected by the total number of children, and by the specific group in question.

In both parts of the figure, the choices are given in the following order: (a) three-year old boys; (b) two-year old boys; (c) three-year old girls; (d) two-year old girls; and (t) total for each toy studied. In the left part of the figure, an arrow points to the total percentage choices.

ing groups were employed:

Materials used in constructing other objects,
(blocks, trains, wagon, wheelbarrow)

Materials involving manipulative skill of small muscles.
(puzzles, nests, pegs, concentric figures, pyramid, etc.)

Toys used in playing house.
(doll corner, dolls, dishes)

Materials requiring considerable physical activity.
(slide, seesaw, and large balls)

Materials used in creative design.
(paints, clay, etc.)

Picture Books

Materials requiring only a small amount of physical activity.
(pull toys, truck, and cars)

TABLE 1

Popularity of Groups of Toys as Indicated by Frequency of Choice

(Percentage of the total choices within each designated class of children)

Toy Group	3-Yr. Old Boys	2-Yr. Old Boys	3-Yr. Old Girls	2-Yr. Old Girls	Boys Combined	Girls Combined	3-Yr. Olds Combined	2-Yr. Olds Combined	Total
Materials Used in Constructing Other Objects (Blocks, etc.)	24.9%	22.5%	15.4%	15.2%	23.7%	15.3%	20.1%	18.8%	22.0%
Materials Involving Manipulative Skill of Small Muscles	16.5	29.4	27.9	18.5	22.9	23.2	22.2	23.9	20.0
Toys Used in Playing House	9.6	14.4	29.7	25.0	12.1	25.6	19.8	20.1	18.3
Materials Requiring Considerable Physical Activity	22.1	10.4	12.9	13.2	20.1	12.8	15.8	15.7	16.5
Materials Used in Creative Design	12.1	4.8	12.7	15.4	9.4	14.0	9.9	10.3	11.4
Picture Books	8.2	4.5	2.0	5.6	6.4	4.1	4.7	5.1	5.4
Materials Requiring Small Amount of Physical Activity	5.5	4.3	1.3	2.6	4.8	2.0	3.2	3.0	3.0

A study of this table will show that, for all children of this age group, materials used in constructing other objects rank first, those requiring manipulative skill of small muscles and those used in playing house jointly coming second, those requiring considerable physical activity ranking third, those used in creative design fourth, picture books fifth, and those requiring only a small amount of physical activity last.

With regard to the most popular type of play material -- that used to build other objects -- this type of material was slightly more popular with girls than with boys, although it was chosen with equal frequency by three-year old and by

two-year old children.

Interest in such toys as puzzles, nests, concentric patterns, and other similar articles which call for manipulative skill in handling was displayed to the same degree by girls and boys, and by the children of both of the ages included in the study.

Although there was no difference in the popularity of articles needed for playing house between three- and two-year old children, there was found to be a significantly greater preference for these materials by girls than by boys. This difference was found to be less for two-year old than for three-year old children.

Girls showed a slight tendency toward a greater interest in materials needed for drawing, modeling, and other activities of this sort than boys, and two-year old boys were behind three-year old boys in this interest.

Picture books, although constituting but 5.4 per cent of the total choices of all of the children, appeared to be enjoyed slightly more by boys than by girls. The number of choices involved in this particular case, however, was too small to establish a significant difference.

Pull toys, and other similar articles requiring but a small amount of physical activity, were not especially popular with the children of two and three years, probably because these were of greater interest to the younger children of this study, and those still younger than the ones included here.

The use made by each of the materials chosen by the children was noted in the record, and this will be presented in a later paper. In passing a few examples of interest in this connection seem worthy of mention. In playing with a nest of eggs, a boy of 27 months was observed to put the nest together twenty-two times in fifty-five minutes, each time (until the last), making some such mistake as leaving out some of the pieces. He was heard to say, "too bad, too bad" when an error was made, only to start over again familiarizing himself with form and color until the nest was mastered.

In using clay, children were frequently seen to model various well-known articles, particularly animals, later naming the objects created and playing games in which these objects were featured. In some cases, a child's chief interest seemed to be to finish the operations necessary in assembling the puzzles or nests left incompleted by other children. In other cases, certain children seemed to make their chief activity the putting away of toys not put away by other children.

The use of the same toy by children of different ages is of particular interest in this connection. A child of two is likely to play with dishes by crowding onto a table all of the dishes possible, with no apparent order or purpose. At three, he is likely to set the table in an orderly manner, playing at having a meal. Another example showing the use of toys progressively at different age levels is that of the doll buggy. A boy of two is likely to push an empty doll carriage around more or less aimlessly for something on wheels to push. At three, the same child will place a doll in the carriage and play that he is taking a baby to the doctor for treatment.

This is a report of a study in which the interests in play materials of boys and girls of pre-school age were investigated. A table of the preferences shown by the children in 32 toys, coming under 7 different classes, is given. This should be helpful to parents and others wishing to choose toys which children of two and three years of age would enjoy.

CHANGES IN BODY PROPORTIONS DURING INFANCY AND THE PRESCHOOL YEARS: II. WIDTH OF HIPS IN RELATION TO SHOULDER WIDTH, CHEST WIDTH, STEM LENGTH, AND LEG LENGTH

VIRGINIA B. KNOTT AND HOWARD V. MEREDITH[1]

INTRODUCTION

"It has long been recognized that the development of the vertebrate embryo tends, in general, to proceed from the cephalic to the caudal pole of the body-stem, from the proximal to the distal segments of the extremities, and, possibly, from the dorsal to the ventral surfaces or regions of the body." (9, p. 267) More recently, it has been found that this general principle of developmental direction has numerous applications beyond the embryonic period. Schultz (10, 11), in particular, has sought anthropometric evidence of expression of the principle in the fetal growth of man and other primates.

Illustrative examples of findings for the fetal period (the period extending from the third prenatal month to the beginning of postnatal life) are available on human material in such major investigations into physical growth as those by Schultz (10, 11), Scammon and Calkins (9), and Boyd (2). Boyd made a critical evaluation and synthesis of research relating to the growth of the human body in surface area. She found the total area of the surface of the body at the beginning of the fetal period to be apportioned as follows: 33 per cent to the head region, 36 per cent to the trunk region, 13 per cent to the upper extremities, and 18 per cent to the lower extremities. By the close of fetal life, the total area was distributed with 21 per cent to the head, 32 per cent to the trunk, 17 per cent to the upper extremities, and 30 per cent to the lower extremities. The fetal growth period was thus found to be characterized by an increase in the surface area of the trunk relative to the head and by an increase in the surface area of the legs relative to the head, the arms, and the trunk. Boyd concluded that "This general pattern of the age progression in proportionate parts...definitely demonstrates the existence of a fundamental increasing gradient of growth in the fetal period from the head downward...and indicates its probable extension into the postnatal period." (2, p. 123)

Scammon and Calkins (9) studied human growth during the fetal period with respect to seventy-one external dimensions of the body. Their subjects were upwards of 400 well-preserved, Caucasian fetuses. Selected findings from these authors which show marked changes in body proportions between the beginning and the close of the fetal period are: (1) the length of the head and neck -- vertex to suprasternal notch -- decreases from 35.6 per cent of total length at three fetal months to 28.4 per cent of total length at ten fetal months, (2) stem length -- vertex to rump -- decreases from 73 per cent of total length at three fetal months to 67 per cent of total length at ten months, (3) length of the upper limb -- acromion to tip of middle finger -- decreases from 103.8 per cent of the lower limb length -- trochanter to heel -- at three months to 94.2

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CHILD DEVELOPMENT, Vol. 8, No. 4 (December, 1937)

per cent of lower limb length at ten months, (4) breadth of the pelvic girdle -- bi-cristal diameter -- increases from 56.6 per cent of the breadth of the shoulder girdle -- bi-acromial diameter -- at three months to 70.0 per cent of the shoulder girdle at ten months, (5) lower limb length increases from 45.3 per cent of stem length at three months to 62.1 per cent of stem length at ten months, and (6) lower limb length increases from 110 per cent of trunk length -- suprasternal notch to symphysis pubis -- at three months to 132 per cent of trunk length at ten months. Alternatively, Scammon and Calkins arrive at the same principle implied in their proportionate findings by analyzing the rate of growth for each individual dimension and showing that as this rate declines during the fetal period the decline "is more pronounced for the dimensions of the head and neck than for those of the trunk, and is greater for dimensions of the trunk than those of the pelvis and extremities." (9, p. 277)

Schultz (11) analyzed data for a large series of physical measurements taken on more than 600 human fetuses. Included among his findings are the following items: (1) stature in percentage of stem length increases from 132 at three fetal months to 148 at ten fetal months, (2) bi-trochanteric diameter of the hips in percentage of bi-acromial diameter of the shoulders increases from 68 at three fetal months to 84 at ten fetal months, (3) length of the forearm in percentage of length of the upper arm increases from 74 at three months to 79 at ten months, (4) length of the lower leg in percentage of length of the thigh increases from 69 at three months to 79 at ten months, and (5) total length of the upper extremity in percentage of total length of the lower extremity decreases from 117 at three months to 104 at ten months. These findings indicate that with advance in fetal growth the legs become longer in relation to the arms and to the body stem, the more distal segments of the upper and lower limbs (forearm and lower leg) become longer in relation to the proximal segments, and the trunk becomes relatively broader at its lower end. In another paper (10) Schultz has presented some additional findings showing that the growth of the trunk is at least partially explained "by a general rule of development, according to which the cephalic end of the body shows an initial acceleration as compared with the more caudal portions." (10, p. 150) This evidence consists of a study of age changes in the spinal column. The length of the different regions of the praesacral spine are expressed in percentage of the total length of the praesacral spine. It is found that in the human fetus the cervical region comprises 26 per cent of the total, the thoracic region 49 per cent, and the lumbar region 25 per cent, while in the adult the percentages are 22 cervical, 46 thoracic, and 32 lumbar. The relative decrease in the cervical and thoracic regions is interpreted as an expression of the embryological principle of an initially retarded development of the caudal region of the body which, subsequently, implies a more intense rate of growth in the lumbar or caudal region of the praesacral spine.

To what extent does physical growth during infancy and the preschool years conform to this general pattern for the embryo and fetus? More specifically, to what extent does the principle of developmental direction extend into postnatal life and characterize physical growth between birth and six years of age? Scattered findings are available for the stem/stature index, the hip/stature index, the hip/stem index, the arm/leg or intermembral index, the chest/hip index, and the hip/shoulder index. Additional information on the question is furnished by Boyd's (2) monograph on the surface area of the body, by the investigation to be reported in this paper, and, indirectly, by studies giving means at frequent age

intervals for separate dimensions of the head, trunk, and extremities.

The stem/stature index has been studied by Stockton-Hough (12), Bayley and Davis (1), Wallis (13), and Hejinian and Hatt (7). Stockton-Hough found the length of the body stem to average 65.2 per cent of the total length for 330 newborn white males and 65.8 per cent of total length for 382 newborn white females. Bayley and Davis took seriatim stem and stature measurements on thirty-one male infants and thirty female infants. They obtained an index trend for both sexes combined which increased from 65.1 at one month to 65.3 at three months, fluctuated around 65.3 between three and seven months, and then decreased to 56.8 at three years. Hejinian and Hatt found means for the stem/stature index, based on thirty to sixty cases for each sex at successive six-month age intervals, to decrease from 61.0 at two years to 56.7 at five years. Wallis obtained mean stem/stature indices at annual intervals from two to six years of age. She found stem length to approximate 60.5 per cent of total length at two years and 55.7 per cent of total length at six years. Since these studies may be summarized as indicating that the stem/stature index decreases from 65.5 at birth through 60.5 at two years to 55.7 at six years, it follows that, in general, the legs grow at a faster rate than the body stem during the first six years of postnatal life.

The trend for the hip/stature index during infancy and the preschool years has been partially studied by Bayley and Davis (1), Lucas and Pryor (8), and Davenport (5). Bayley and Davis found bi-trochanteric diameter of the hips to equal 19.9 per cent of total length at one month, 21.6 per cent at seven months, and 18.8 per cent at three years. Lucas and Pryor found bi-cristal diameter of the hips in percentage of stature to decrease from a mean of approximately 17.4 at six months to a mean of 16.0 at six years. Davenport obtained means for hip/stature index of 16.1 at six years of age for both males and females. His subjects were Brooklyn orphan asylum children of Nordic stock, and the hip measurement employed was bi-cristal diameter. The findings from these studies suggest that hip width increases in relation to stature during the early months of postnatal life, and from this time to six years of age it shows a tendency to relative decrease.

For elucidation of the principle of developmental direction it is obviously less meaningful to relate hip width to stature than to relate it to the components of stature which lie, in the main, either above (stem length) or below (leg length) the level of the hips. Means for hip/stem index are included in the previously cited reference by Bayley and Davis. These authors found bi-trochanteric diameter of the hips to equal 30.6 per cent of the stem length at one month, 33.2 per cent at six months, 32.6 per cent at nine months, and to remain approximately constant from nine months until two years of age, when it stood at 32.7 per cent. Viewing these findings in relation to those given above for the hip/stature index, the following inference may be tentatively drawn: hip width increases both in relation to stem length and leg length during the early months of postnatal life, while from this time until at least two years of age it remains relatively constant in relation to stem length and decreases in relation to leg length. This inference has been tested in the present investigation.

Wallis (13, 14) made two studies in which she obtained the arm/leg, or intermembral, index. In both instances the index was found to fall steadily from two to six years of age. The rate of decrease lessened with age and amounted to roughly 10 index points for the four-year period. It thus appears that during the preschool years leg length increases faster than arm length to the extent

that in the four-year interval arm length decreases by 10 per cent in its relation to leg length.

The chest/hip index has been studied by Freeman (6) on New York children. He obtained mean indices for width of chest in percentage of hip width of 108.2 for 160 males at one day after birth and 109.1 for 149 females at the same age. Additional cases for each sex between one and six years ranged from 18 to 53 for successive one-year age groupings. The mean index declined, for males, from 113.1 at one year to 98.2 at six years and, for females, from 111.6 to 94.9 over the same age span. Unfortunately, Freeman did not state at what level the transverse diameter of the thorax was measured, or what landmarks were used in taking hip width.

Davenport (5) and Wallis (13) have reported findings for the hip/shoulder index. Davenport measured intercristal and bi-acromial diameters on five newborn infants, eighteen infants ranging in age between two and 107 postnatal days, and a larger group of males aged six years. He found the index to increase from 76 at birth to 78 at about six postnatal weeks and to decrease to 70.2 at six years. Wallis took the same hip and shoulder measurements on a small sampling of children two to six years of age. She found the width of the hips to approximate 70 per cent of shoulder width at two years and 72 per cent of shoulder width at six years. It will be noted that Wallis' trend from two to six years harmonizes with the principle of developmental direction but that Davenport's figures indicate a contradictory trend after about six postnatal weeks. Further study of this index has been made in the present investigation.

Finally, it is relevant to mention Boyd's (2) findings for surface area during infancy and the preschool years. She reports that the surface area of the head decreases from 20.8 per cent of the total surface area of the body at birth to 12.6 per cent of the total area at six years of age. In contrast, the surface area of the upper extremities increases from 16.8 per cent of the total at birth to 19.6 per cent at six years, and a still greater increase for the lower extremities -- from 30.5 per cent of the total at birth to 34.4 per cent at six years. These findings clearly harmonize with the principle of developmental direction.

PURPOSE

The present investigation was undertaken to ascertain the developmental trend for certain human proportions during the age period from birth to six postnatal years. Following preliminary study of the literature, it was decided that bi-iliac diameter of the hips be used as a focal dimension and that this be related to two major length measurements and two major breadth measurements. The four indices selected for analysis were:

Hip/Stem Index, or bi-iliac diameter in percentage of vertex-rump length

Hip/Leg Index, or bi-iliac diameter in percentage of vertex-heel length minus vertex-rump length

Hip/Shoulder Index, or bi-iliac diameter in percentage of bi-deltoid diameter

Hip/Chest Index, or bi-iliac diameter in percentage of transverse diameter of the thorax at the level of the xiphisternal junction

What statement can be formulated as to the probable course of the mean curve for each of these indices during infancy and the preschool years? Inference from the studies discussed above and from other research on physical growth during early postnatal life yields the following hypotheses:

1. The hip/stem index increases during the early months of postnatal life and from this age to six years either remains constant or shows a slight increase.

2. The hip/leg index increases during the early months of postnatal life and then decreases markedly to six years of age. Leg length thus grows faster than hip width over more than five-sixths of the age span under study.

3. The hip/shoulder and hip/chest indices register an increase between birth and six years. The increase is probably more marked during the early months of infancy than during the preschool years.

It is the purpose of this study to test these hypotheses and to determine the amount of increase or decrease from age to age.

DATA

The basic data are approximately 3,500 measurements each for hip width, chest width, stem length, and stature, and 2,800 measurements for shoulder width. These data were accumulated by the anthropometric staff of the Iowa Child Welfare Research Station during the years 1929 to 1936. Observations for hip width, along with one or more of the other four dimensions, were available for fifty males and fifty females aged twenty-four to forty-eight postnatal hours and for 557 males and 448 females between the ages of one month, fifteen days and six years, two months, fourteen days. The former group consisted of full-term white infants of American parentage measured at the University hospital, Iowa City. Their records carried values for hip width, stem length, and stature. The latter group was measured at the University of Iowa infant laboratory, preschool laboratories, and elementary school. Many of these children had repeated measurements over a period of two years or more.

With respect to the larger group of subjects, care was taken to see that in no instance was the record marked as applying to an individual of Negroid, Mongoloid, Jewish, or southeast European stock, or to an individual who was physically pathological. About 50 per cent of the records gave detailed information concerning the birthplace of parents and grandparents, and occupational status of the father.

Analysis of the birthplace items showed that both parents of 92 per cent of the children and all four grandparents of 55 per cent of the children were born in the United States. Tabulation of the occupational status data revealed that 31 per cent of the fathers were of the professional class, 24 per cent were managers, salesmen, or business proprietors, 41 per cent were skilled trade employees, clerks, or carriers, and 4 per cent were day laborers.

It is apparent, then, that the sample employed is homogeneous in regard to geographical location (Iowa City children) and not greatly diverse as to ethnic stock (American-born children of northwest European ancestry). With reference to socio-economic level, the sample is predominantly composed of the professional and managerial classes.

The measurements on both groups of subjects were taken according to the following technique:

Hip: Bi-iliac diameter of the hip was measured with the large, straight-arm, sliding calipers (Hrdlička compass). Sufficient pressure was used to approximate a bony measurement of the maximum width between the crests of the ilia.

Stem: The technique varied according to the age of the subject. Below two years of age, the stem (vertex-rump) length was taken on the Baldwin Measuring Board for Infants. From two years on, stem length was obtained with the subject in an erect sitting position.

Leg: Leg length was not directly measured, but was derived as stature minus stem length. As in the case of stem length, stature was determined in the recumbent position on subjects below two years of age and in the erect standing position (with heels, buttock, upper part of back, and occipital region of head in contact with the vertical measuring scale) on subjects older than two years.

Shoulder: Bi-deltoid diameter of the shoulders was taken with the large, straight-arm, sliding calipers. Firm contact was used. (Bi-deltoid diameter is employed in the present study not because it is preferred to bi-acromial diameter but because bi-acromial diameter was not available for subjects younger than two years of age.)

Chest: Transverse diameter of the thorax was taken with the Hrdlička compass. The measurement was recorded as the mid-respiration value at the level of the xiphisternal junction.

HIP/STEM INDEX

Bi-iliac diameter in percentage of stem length was calculated for 2,009 paired measurements on males and 1,596 paired measurements on females. The resulting index values were distributed into nineteen age groupings for each sex. Table 1 lists the number of observations within each age grouping and shows the analysis made for each of the thirty-eight series of index values. Curves drawn to the successive index means for males and females are given in Figure 1. Examination of this tabular and graphic material reveals the following findings:

1. The amount of change in the hip/stem index between birth and six years of age is not great. At birth, bi-iliac diameter in percentage of vertex-rump length averages approximately 24.5. By six years of age the mean index has risen to slightly more than 29 per cent. The amount of increase in the mean index for the six-year age span stands at 4.5 per cent for males and 5.1 per cent for females.

2. The only marked change in the proportionate relation between hip width and stem length occurs during the period from birth to three months of age. For males there is an increase in mean index from 24.7 per cent at birth to 28.1 per cent at three months. The corresponding increase for females is from 24.4 per cent to 27.9 per cent.

3. There is a moderate rise in the hip/stem index between three and six months of age. Combining this rise with the more marked rise from birth to three months, it appears that roughly 87 per cent of the increase in the index from birth to six years is made between birth and six months.

4. The hip/stem index changes but little between six months and six years of age. During the interval from six months to three years the mean trend shows first a slight decline and then a compensating rise. This retardation and acceleration, however, is confined within the narrow zone of 28 to 29 per cent. From three to six years the mean indices remain relatively constant, falling between 28.9 and 29.2 for males and, for females, between 29.2 and 29.7.

5. There is no marked sex difference apparent in the relation of hip width to stem length. On the whole, the males tend to show a lower index than the females and at four years, six months the difference was found to be statistically significant. Since Boynton (3) has shown that males slightly exceed females in mean bi-iliac diameter during infancy and the preschool years, this lower index

implies that males surpass females by a greater margin in the stem component of this index than they do in the hip component.

TABLE 1

Bi-iliac Diameter of Hips in Percentage of Vertex-Rump Length or Sitting Height*

Mean Age Year	Mean Age Month	Cases	Mean	Standard Error of Mean	Standard Deviation	Range
			Males			
	0**	50	24.7	.20	1.41	20.4 to 28.2
	3	68	28.1	.22	1.73	23.7 to 33.4
	6	100	28.8	.19	2.03	24.1 to 34.4
	9	136	28.6	.16	1.76	24.6 to 33.3
1	0	162	28.5	.13	1.60	25.3 to 33.0
1	3	141	28.3	.12	1.47	24.8 to 32.1
1	6	118	28.0	.12	1.29	25.0 to 31.2
1	9	103	28.1	.12	1.21	25.5 to 30.4
2	0	109	28.4	.14	1.41	25.3 to 31.8
2	3	101	28.4	.12	1.19	25.9 to 31.3
2	6	94	28.6	.13	1.24	25.0 to 31.5
2	9	97	28.6	.11	1.11	26.4 to 31.5
3	0	113	28.9	.12	1.32	26.2 to 31.6
3	6	106	29.0	.11	1.18	26.6 to 32.2
4	0	102	29.1	.12	1.18	25.9 to 31.7
4	6	100	29.0	.12	1.17	25.8 to 32.1
5	0	102	29.2	.12	1.23	26.5 to 32.1
5	6	110	29.2	.12	1.24	26.4 to 32.2
6	0	101	29.2	.11	1.12	25.6 to 32.3
			Females			
	0**	50	24.4	.16	1.10	22.4 to 27.8
	3	51	27.9	.28	2.03	22.7 to 32.8
	6	106	28.7	.21	2.14	24.1 to 34.1
	9	117	28.6	.18	1.93	24.4 to 33.8
1	0	119	28.5	.16	1.77	24.7 to 33.1
1	3	108	28.3	.16	1.64	24.7 to 31.9
1	6	98	28.5	.13	1.29	25.5 to 32.1
1	9	87	28.4	.15	1.36	25.4 to 31.3
2	0	74	28.4	.15	1.27	25.4 to 31.2
2	3	76	28.2	.13	1.12	25.6 to 31.3
2	6	80	28.7	.12	.99	26.3 to 32.0
2	9	66	28.8	.14	1.17	26.5 to 31.2
3	0	66	29.2	.13	1.00	26.8 to 31.5
3	6	75	29.4	.14	1.18	26.4 to 33.4
4	0	76	29.8	.16	1.37	26.8 to 33.8
4	6	84	29.7	.14	1.26	27.2 to 33.5
5	0	94	29.4	.12	1.18	26.8 to 33.7
5	6	93	29.3	.14	1.37	26.1 to 33.3
6	0	88	29.6	.14	1.30	27.1 to 33.4

*The basic data were obtained from measurement of Iowa City males and females of northwest European descent.
**The statistical constants at this age are derived from data for fifty infants of each sex measured two days following birth.

HIP/LEG INDEX

Results of the analysis for this index are given in Table 2. The procedure of age grouping was similar to that used above, the index values being derived from 2,009 paired measurements for males and 1,594 paired measurements for females. Figure 2 shows curves drawn to the mean values for males and females. Findings are:

1. The mean trend for hip/leg index is characterized by an initial abrupt rise from birth to three months. This rise is followed by a sweeping fall which is prolonged at a decreasing rate throughout the entire period from three months to six years of age.

2. The amount of change in the proportion of hip width to leg length during

the age span from birth to six years is approximately 11.5 per cent for both sexes. The maximum change, however, is almost double this amount. For males, the mean index stands at 57.3 at three months -- 21.1 per cent higher than its value at six years. For females, the decline from three to six years is from 56.7 to 36.1, or 20.6 per cent.

3. The abrupt rise in the index from birth to three months is accounted for by the fact that bi-iliac diameter is growing rapidly at this time. From a mean bi-iliac diameter of 7.9 cms. at birth, there is an increase of roughly 40 per cent for the next three months (to 11.2 cms.). The corresponding percentage increase for rump-heel length is around one-half this amount (from approximately 16.5 cms. at birth to 19.9 cms. at three months).

4. Subsequent to this initial spurt in hip width the legs lengthen rapidly in proportion to the widening of the pelvic girdle. By one year, three months the index approximates its birth value and by six years of age it has decreased

TABLE 2

Bi-iliac Diameter of Hips in Percentage of Length of Lower Extremities*

Mean Age Year	Mean Age Month	Cases	Mean	Standard Error of Mean	Standard Deviation	Range
Males						
	0**	50	48.0	.58	3.91	40.7 to 57.3
	3	65	57.3	.75	6.02	45.2 to 71.7
	6	109	55.6	.58	6.01	41.5 to 70.2
	9	136	52.7	.38	4.44	43.4 to 63.0
1	0	152	49.9	.31	3.79	41.9 to 59.9
1	3	141	47.8	.27	3.15	40.8 to 57.8
1	6	118	45.9	.23	2.47	39.8 to 52.4
1	9	103	45.2	.26	2.62	39.7 to 52.4
2	0	109	44.4	.25	2.58	39.0 to 50.8
2	3	101	43.5	.22	2.18	38.5 to 49.5
2	6	94	42.8	.20	1.98	38.3 to 47.3
2	9	97	41.9	.20	2.00	37.5 to 48.4
3	0	113	41.6	.20	2.12	37.5 to 46.9
3	6	106	40.5	.18	1.88	36.1 to 45.2
4	0	102	39.4	.18	1.83	35.6 to 44.2
4	6	100	38.7	.16	1.65	35.0 to 42.9
5	0	102	37.7	.18	1.84	33.5 to 41.9
5	6	110	36.9	.17	1.74	32.5 to 41.2
6	0	101	36.2	.16	1.66	32.7 to 40.4
Females						
	0**	50	47.5	.49	3.46	41.0 to 55.1
	3	61	56.7	.99	7.08	41.8 to 70.1
	6	106	54.4	.47	4.89	43.9 to 67.4
	9	116	51.7	.41	4.48	43.6 to 64.0
1	0	119	49.6	.35	3.81	38.3 to 58.1
1	3	108	47.2	.33	3.38	39.1 to 54.2
1	6	98	46.1	.27	2.69	40.6 to 52.7
1	9	87	44.0	.28	2.64	39.1 to 51.7
2	0	74	43.6	.28	2.39	37.8 to 48.9
2	3	76	42.5	.24	2.06	38.4 to 47.2
2	6	68	42.2	.26	2.14	38.4 to 46.4
2	9	66	41.5	.27	2.21	37.7 to 46.1
3	0	68	41.0	.25	2.02	37.5 to 45.0
3	6	75	40.0	.21	1.85	35.3 to 44.4
4	0	78	39.4	.24	2.08	35.3 to 44.7
4	6	84	38.7	.22	2.01	34.8 to 43.7
5	0	94	37.3	.19	1.88	32.8 to 42.1
5	6	92	36.6	.20	1.87	31.5 to 41.2
6	0	88	36.1	.19	1.79	31.8 to 41.9

*Bi-iliac diameter was taken as a direct measurement and length of lower extremities derived as stature minus sitting height. The subjects were Iowa City males and females of northwest European descent.

**The analyses at this age are based on data for fifty infants of each sex measured two days following birth.

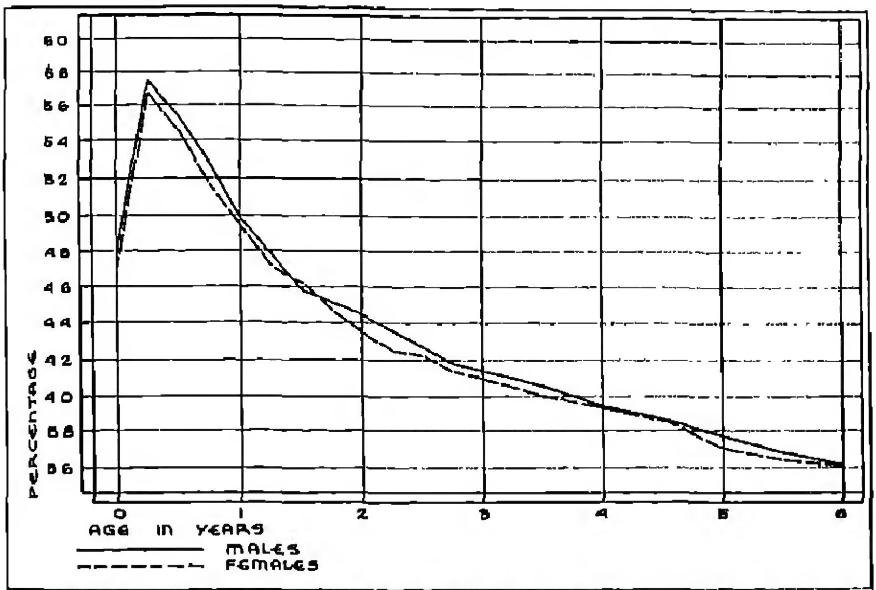

Figure 2. - Hip/Leg Index: Curves for Males and Females Drawn to the Series of Mean Values Given in Table 2.

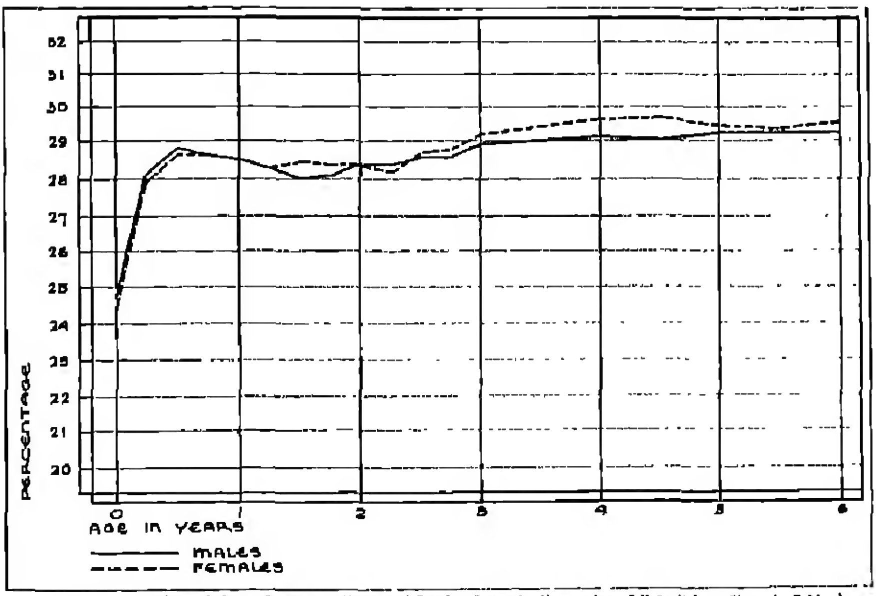

Figure 1. - Hip/Stem Index: Curves for Males and Females Drawn to the Series of Mean Values Given in Table 1.

to more than 11 index points below this value. The decline is especially marked until about two years of age.

5. The curves for the two sexes follow each other closely. In the main, males tend to show a higher index than females, though the difference is not statistically significant except at two years, three months. There is little indication of the relatively wider hips and shorter legs which have been posited to characterize the adult female.

6. Between three months and six years of age the variability, as measured by the standard deviation and range, decreases for each successive age group. This steady decline in absolute variation is perhaps to be explained, in part, on the basis of individual differences in the time of acceleration in the rate of growth for leg length and, in part, as a function of the increasing difference with age between the magnitude of hip width and the magnitude of leg length.

HIP/SHOULDER INDEX

The hip/shoulder index was obtained as bi-iliac diameter in percentage of bi-deltoid diameter. As previously pointed out, bi-deltoid diameter was used as the shoulder component of the index since measurement values for bi-acromial diameter were not available below two years of age. Indices were computed from 1,626 and 1,204 paired measurements for males and females, respectively. The reduction in the number of paired observations for this index is due to the fact that there were fewer records for bi-deltoid diameter toward the upper end of the age scale (bi-acromial diameter being the routine shoulder measurement made on the preschool children).

The procedure in analysis paralleled that described for the hip/stem index. Table 3 gives the results. Trends drawn to the series of means for each sex are presented in Figure 3. The irregularities in the female trend between three and six years of age are probably accounted for in that the number of observations within each age grouping for these years is less than fifty.

In order to obtain an estimate of the percentage relation of bi-iliac diameter to bi-deltoid diameter at birth, hip/shoulder ratios were calculated from mean values for each dimension given by Cates and Goodwin (4). These means were based on upwards of 300 twelve-day-old infants of each sex. The ratios obtained are 61.5 for males and 62.2 for females.

Table 3, supplemented by Figure 3 and by the approximate birth values for the index, yields the following findings:

1. There is a sharp rise in hip/shoulder index between birth and three months of age. The mean index at birth is estimated at 61.5 for males and 62.2 for females. The mean index at three months is found to be 68.8 for males and 69.2 for females. It follows from these figures that the bi-iliac diameter of the hips in its percentage relation to bi-deltoid diameter of the shoulders increases by about 7 per cent during the first three postnatal months.

2. From three months to around one year of age the mean hip/shoulder index registers a moderate decrease. This decrease extends to 67.4 per cent at one year for females and to 67.1 per cent at one year, three months for males. It thus amounts to approximately 1.75 per cent for each sex.

3. There is a gradual acceleration in the percentage relation of bi-iliac diameter to bi-deltoid diameter from the early part of the second year to about four and one-half years of age. For males, this acceleration raises the mean

index from 67.1 at one year, three months to 71.1 at four years, six months. The ascent for females, while less regular, likewise appears to give an increase in mean index in the vicinity of 4 per cent.

4. Between four and one-half years and six years of age the hip/shoulder index appears to remain roughly constant. In view of the paucity of observations on which means for this segment of the age span are based, the inconclusiveness of this formulation should not be overlooked. The obtained mean indices at four years, six months to six years will be seen to show minor fluctuation around 71.1 for males and to decrease from 72.2 to 71.2 for females.

5. Inspection of the hip/shoulder index trends with reference to sex differences reveals the slight (though not statistically significant) tendency for males to have wider shoulders relative to their hip width than females.

TABLE 3

Bi-iliac Diameter of Hips in Percentage of Bi-deltoid Diameter of Shoulders*

Mean Age Year	Mean Age Month	Cases	Mean	Standard Error of Mean	Standard Deviation	Range
			Males			
	3	65	68.8	.42	3.42	58.8 to 78.4
	6	100	68.7	.42	4.39	60.1 to 78.6
	9	136	67.9	.33	3.84	60.3 to 76.2
1	0	162	67.3	.32	4.01	58.0 to 78.3
1	3	141	67.1	.27	3.24	60.4 to 77.9
1	6	118	67.4	.29	3.19	61.3 to 76.8
1	9	103	67.8	.30	3.08	60.5 to 75.4
2	0	109	67.8	.29	3.01	60.1 to 74.6
2	3	101	68.3	.29	2.94	61.2 to 75.2
2	6	94	68.9	.32	3.16	60.9 to 76.2
2	9	97	69.2	.31	3.06	63.4 to 76.5
3	0	96	69.5	.31	3.02	62.6 to 76.9
3	6	86	70.1	.32	2.93	63.1 to 77.9
4	0	71	70.7	.42	3.63	62.9 to 79.2
4	6	54	71.1	.47	3.44	63.7 to 78.9
5	0	39	71.1	.53	3.32	63.6 to 80.2
5	6	31	71.2	.57	3.15	66.2 to 78.7
6	0	24	70.8	.55	2.67	66.2 to 78.1
			Females			
	3	51	69.2	.60	4.25	58.3 to 80.0
	6	106	69.1	.40	4.09	60.7 to 80.2
	9	117	68.3	.35	3.80	57.4 to 78.0
1	0	119	67.4	.34	3.76	57.8 to 74.9
1	3	108	67.6	.34	3.50	60.0 to 76.5
1	6	97	67.9	.30	2.95	61.0 to 76.8
1	9	87	67.8	.31	2.89	61.3 to 75.1
2	0	74	68.1	.34	2.96	62.2 to 75.6
2	3	72	68.1	.33	2.82	61.9 to 74.6
2	6	61	68.9	.32	2.52	63.0 to 75.8
2	9	56	69.4	.44	3.32	62.3 to 76.5
3	0	53	70.2	.37	2.71	64.9 to 76.7
3	6	46	70.9	.45	3.08	64.2 to 79.2
4	0	31	71.1	.65	3.62	63.1 to 81.9
4	6	39	72.2	.57	3.52	67.1 to 81.9
5	0	32	71.8	.66	3.76	65.9 to 83.8
5	6	20	71.1	.92	4.09	64.9 to 81.0
6	0	34	71.2	.52	3.04	65.8 to 78.3

*The basic data are measurement values for Iowa City males and females of northwest European descent.

HIP/CHEST INDEX

The number of basic measurements available for computation of this index approximated the numbers for the hip/stem and hip/leg indices. Specifically, there was a total of 3,501 paired measurements, 1,960 for males and 1,541 for

for bi-iliac diameter in percentage of chest width at the level of the xiphoid. From the estimated value of 77 for the index immediately before birth, the mean indices have risen to 89.3 for males and 90.4 for females. The major portion of this rise occurs during the first half of the interval.

3. The mean hip-chest index shows a slight decrease during the latter part of the first year. For both males and females the amount of the decline is less than one index point.

4. For the age interval beginning early in the second year and extending through to six years, each series of means gives a progressively rising trend. For females, the ascent is from 89.6 at one year to 102.3 at six years. For males, it is from 88.5 at one year, three months to 101.2 at six years. The increase over the five-year period is thus found to be 12.7 for each sex.

5. There is a consistent sex difference in mean hip/chest index. Over the entire age interval from three months to six years, each successive mean for males is from 1 to 2.5 per cent less than the mean for females at a corresponding age. The differences are statistically significant at one year, six months; two years, nine months; and three years, six months.

6. An interval of one year is found between the age at which hip width equals chest width in males and females. For females, the hip/chest index approximates 100 at four years, six months, while for males this figure is not reached until five years, six months.

It will be recalled that Freeman (6) found the chest/hip index to increase from around 109 at one day of age to 113 at one year, and then to decrease steadily to 98 at six years. When converted into the form hip/chest, these mean indices indicate a decreasing trend from 92 at one day to 88 at one year followed by an ascent to 102 at six years. The rise from 88 to 102 over the age period from one to six years closely parallels the trend obtained in the present investigation (See Figure 4). Freeman's value at one day of age, however, is 15 per cent higher than the index of 77 for the end of the fetal period derived from Scammon and Calkins. This discrepancy is probably due to the abrupt change in the size of the thorax consequent to the establishment of respiration (9, p. 28-29, 162-171). Nevertheless, it is important that the finding of the present study for the period from the end of prenatal life to three months of age be regarded as the gross trend for this interval. Further research is necessary in order to elucidate the more temporary fluctuations in the hip/chest index during the early days of postnatal life.

INTERRELATION OF INDICES

Birth to Three Months

The four indices under study all register an abrupt proportionate increase in bi-iliac diameter during the early months of postnatal life. That is, neither stem length, leg length, shoulder width, nor chest width grows as rapidly as width of hips between birth and three months of age. This finding is striking. While it is in general harmony with the principle of developmental direction for all relationships but hip/leg, it indicates that the expansion of bi-iliac diameter is sufficiently marked to overshadow the expression of this general principle (or "fundamental pattern") and to stand out as the dominant feature of the age interval. It seems probable that the explanatory factor underlying the acceleration phenomenon for hip width lies in the survival value of narrow hips at birth.

The human process of parturition is obviously facilitated by a slowing of the growth of the fairly rigid pelvic girdle until after birth.

Further analysis of the initial rise in all indices reveals that the amount of rise is less for the hip/stem index than for the hip/leg index and less for the hip/shoulder index than for the hip/chest index. It thus appears that between birth and three months of age (1) leg length grows relatively less than stem length, and (2) bi-deltoid diameter relatively more than chest width at the xiphoid level. The former finding is confirmed by values for the hip/stem and hip/stature indices reported by Bayley and Davis (1). The latter is in line with Davenport's (5) observation that following birth there is a widening of the shoulders relative to chest width which is due in part to the release of the shoulder girdle from intrauterine pressure and in part to the more forward rotation of the glenoid fossae with age.

Three to Fifteen Months

During the interval from three to fifteen months two types of trend are found. The hip/leg and hip/shoulder curves show deceleration over the entire period whereas the hip/stem and hip/chest curves show acceleration to six months of age and decline thereafter.

The hip/stem index rises approximately 1 per cent between three and six months and then falls by about the same amount to one year, three months. The hip/chest index rises almost 2 per cent between three and six months and then decreases by roughly half this amount to one year, three months. The hip/shoulder index declines nearly 2 per cent and the hip/leg index 9.5 per cent during the year.

It will be noted that the trend for the hip/leg index supports the principle or law of developmental direction in that it indicates the lower extremities are growing at a faster rate than the bi-iliac diameter. The other three trends, however, fail to give evidence of conformity to the principle. While the hip/stem and hip/chest indices change but little over the interval, the hip/shoulder trend takes the opposite direction from that which the principle would necessitate.

Fifteen Months to Six Years

During this age span of roughly five years, each of the four indices studied follows a given pattern of growth consistently and without reversals. The hip/leg index decreases, while the hip/stem, hip/chest, and hip/shoulder indices increase in varying amounts.

That the principle of developmental direction extends into the postnatal period to at least six years of age is clearly illustrated by the steep pitch of the trends for the hip/leg index and the hip/chest index. The hip/leg index declines continuously from around 47 at fifteen months to 36 at six years. In contrast, the hip/chest index shows a cumulative increase from approximately 80 at fifteen months to 102 at six years. These changes decisively indicate that leg length is growing at a faster rate than hip width and that hip width is growing at a faster rate than chest width.

The hip/stem index increases slightly, but significantly, from fifteen months to around four years and then remains relatively constant between four and six years. Viewing this finding in relation to the findings for the hip/leg and hip/chest indices, it appears that between fifteen months and six years of age leg length grows more rapidly than stem, and stem length grows more rapidly than chest width. These proportionate changes are at no point contradictory to the principle

of developmental direction.

Finally, the rising trend for the hip/shoulder index is, in itself, in general agreement with the principle or law of developmental direction. However, the hip/shoulder trend rises less sharply (from roughly 67 to 71) than the trend for the hip/chest index. This implies that though hip width is growing at a faster rate than either chest width or shoulder width, the width of the shoulders is growing faster than chest width. Can the higher growth rate for shoulder width than for chest width be explained as due to some special characteristic of development which is superimposed upon the general principle of cephalo-caudal direction? In this connection, Davenport (5) has presented evidence to show that the position of the scapulae changes with age. He writes: "The scapulae when first well developed lie at an angle of 60^0, or more, with the frontal plane, at birth about 50^0 and in the adult about 30^0. The acromial processes thus come to project laterally more prominently." (5, p. 192, 194)

SUMMARY

Bi-iliac diameter of the hips is studied in relation to two major length measurements and two major breadth measurements of the body.

The data consist of approximately 3,500 observations each for bi-iliac diameter, stem length, leg length, and transverse diameter of the thorax, and 2,800 observations for bi-deltoid diameter. These data were accumulated between 1929 and 1938 from measurement of upwards of 1,000 Iowa City children.

Developmental trends extending from birth to six years of age are presented for the following body proportions: hip/shoulder, hip/chest, hip/stem, and hip/leg. Selected findings are:

1. Hip width increases in relation to each of the other dimensions studied during the period from birth to three months of age.

2. Bi-iliac diameter of hips in percentage of leg length decreases from 57 at three months of age to 36 at six years of age.

3. Bi-iliac diameter in relation to transverse diameter of the thorax increases from 87 per cent at three months to 89 per cent at six months, shows a slight decrease between three and fifteen months, and then increases to 102 per cent at six years.

4. Width of hips shows an increase of approximately 2 per cent in proportion to bi-doltoid diameter over the interval from three to six years of age. For the same age span, an increase somewhat less than this amount is registered by the hip/stem index.

The interrelation of the four indices is treated and findings are discussed with reference to the principle or law of "developmental direction."

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ENVIRONMENTAL CORRELATES OF MENTAL AND MOTOR DEVELOPMENT: A CUMULATIVE STUDY FROM INFANCY TO SIX YEARS[1]

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I. INTRODUCTION

The development of methods for the testing of young children has led to a number of studies dealing with the relationship of individual differences to factors in the environment. In the investigations of Goodenough (7), Van Alstyne (12), and others, the test scores of preschool children have been found to be positively correlated with parent's education and occupational ratings. Other studies, notably those of Furfey and his associates (5, 6), have revealed no relationship between these environmental factors and the scores of infants under one year. The present report provides a link between these discrepant findings, and has the further advantage of presenting cumulative results within a uniform, although small, sample. Its principal limitation is that of all studies which are primarily statistical-descriptive, and which lack either an experimental control of variables or an intimate analytic record of the developmental process.

2. THE SAMPLING

The group utilized in this study has figured in a series of previous reports dealing with various aspects of development, (1), (2), (3). The purpose of the main investigation, as well as the practical requirements of a study involving long-continued cooperation from parents, determined to some extent the nature of the sample which was selected. Only hospital babies were used, due to the fact that the program required information concerning the mother's pregnancy and confinement, and also involved tests of the infants during the neonatal period. The sources were two hospitals drawing their clientele from different socio-economic levels. One is a county hospital including charity cases, while the other is a private hospital where cases from all income-levels may be found.

A pediatrician (Dr. L. V. Wolff) visited the hospitals and interviewed the mothers of all new-born infants who were normal at birth and had normal delivery. During the period between September 27, 1928 and May 15, 1929 seventy-five mothers were interviewed. In order to gain greater homogeneity of sampling and to simplify the task of securing information from the parents, cases were restricted to families in which both parents were white and English speaking. They were also restricted to those who had established more or less permanent residence in Berkeley, and who could be expected to be available for cumulative study over a period of years. Of the 75 families interviewed, 59 proved to be cooperative and to meet the criteria for inclusion. The 59 families included two sets of twins, making 61 children in all, 31 boys and 30 girls. Six of the children were born in the county hospital, 55 in the private hospital.

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[2] From Institute of Child Welfare, University of California.

Some of the socio-economic characteristics of the sample are shown in the following tables. For purposes of comparison, the tables include distributions for a larger group of Berkeley families studied during the same period. The members of this larger sample are here designated Group A, and the members of the smaller sample, providing the principal data for the present report, constitute Group B. Group A, known as the Berkeley Survey, is representative of all Berkeley families in which children were born during the 1928-29 period.

TABLE 1

Education of Parents: Years of Schooling

	GROUP A		GROUP B					
	Midparent*		Fathers		Mothers		Midparent*	
Years	N	%	N	%	N	%	N	%
Total	405	100.00	59	100.00	59	100.00	59	99.99
17-20	66	16.30	18	30.51	8	13.56	4	6.78
13-16	128	31.60	18	30.51	23	38.98	32	54.24
9-12	162	40.00	16	27.12	22	37.29	21	35.59
5- 8	38	9.38	6	10.17	6	10.17	1	1.69
1- 4	11	2.72	1	1.69	0	0.00	1	1.69
Mean	11.3		13.7		12.9		13.3	
Median	11.3		14.4		13.3		13.8	
Standard Deviation	3.7		3.6		3.1		3.4	

* The average of years of schooling of the two parents.

TABLE 2

Occupational Classification of Fathers (at birth of child)

	GROUP A Berkeley Survey		GROUP B	
Description	No. of Cases	Percent	No. of Cases	Percent
Total	405	100.	59	100.
Professional and Executive	91	22.5	18	30.5
"White Collar"	150	37.0	22	37.3
Students	13	3.2	6	10.2
Skilled Labor	83	20.5	7	11.8
Semi-skilled Labor	46	11.4	3	5.1
Unskilled Labor	21	5.2	2	3.4
Retired	1	.2	1	1.7

TABLE 3

Annual Income of Growth Study Families Compared with Berkeley Survey

	GROUP A Berkeley Survey		GROUP B	
Annual Income	No. of Cases	Percent	No. of Cases	Percent*
Total	376*	100.	54*	100.
Above $8000	6	1.3	1	1.8
$7000-7999	3	.8	3	5.6
$6000-6999	5	1.6	2	3.7
$5000-5999	16	4.3	2	3.7
$4000-4999	27	7.3	3	5.6
$3000-3999	59	15.7	15	27.8
$2000-2999	96	25.5	15	27.8
$1000-1999	155	41.2	10	18.5
Below $1000	9	2.4	3	5.6
Mean		$2,547.63		$2,844.61
Median		2,020.00		2,650.00
Standard Deviation		1,872.00		1,950.00

* 29 cases in Group A and 5 cases in Group B have been omitted (dependents or incomplete information). The data are for 1928-1929 (at birth of child)

TABLE 4

Frequency Distribution of Stanford-Binet IQs at 72 Months

IQ	GROUP A n 211	GROUP A % 100.0	GROUP B n 48	GROUP B % 100.0
170-179	1	.5		
160-169	-	-		
150-159	1	.5	1	2.1
140-149	7	3.3	5	10.4
130-139	26	12.3	10	20.8
120-129	54	25.6	13	27.1
110-119	70	33.2	12	25.0
100-109	41	19.4	5	10.4
90- 99	10	4.7	1	2.1
80- 89	1	.5	-	-
70- 79	-	-	-	-
60- 69	-	-	1	2.1
Mean	118.6		123.3	
Median	118.0		123.0	
S. D.	12.6		15.6	

Table 1 shows that Group B parents have approximately two years more schooling than the average of Berkeley parents (who themselves constitute a somewhat selected group as compared with urban United States families. For a further description of the Berkeley survey group, see Burks and Jones (4) and Welch (13).) Approximately one-half of the fathers and one-third of the mothers are college graduates. Approximately two-thirds of the fathers and three-quarters of the mothers are high school graduates. Table 2 shows that three-quarters of the fathers are classed in professional and "white collar" occupations, or as students. Table 3 shows that the median annual income of the group (in 1929) was $630 greater than in the more representative Group A of the Berkeley Survey.

Since variability is an important consideration in a correlational study, attention should be directed to the standard deviations of the sample. It might be expected that because of the criterion for selection, Group B, selected for intensive study during infancy, would prove to be a sample not only with a high central tendency but also with a restricted variability. In education of parents, Table 1 shows a standard deviation for the Group B only slightly smaller than that found for Group A. Table 2 indicates for both samples a skewing in occupational status, particularly marked in the case of Group B and resulting in decreased variability. This is not paralleled, however, by the data on income (Table 3).

Turning to measures of the children, 211 of the children in Group A and all in Group B were given numerous mental tests during the preschool period. At the age of 6 years they received a Stanford-Binet test. It is probable that familiarity with test procedures has had some effect in raising the obtained IQ's for both groups. It may be noted (Table 4) that Group B has a higher average IQ, but a degree of variability representative of what is commonly found with unselected samples.

3. THE MENTAL AND MOTOR TEST DATA

The program of mental testing for Group A has been as follows: From birth through 15 months the children were tested at one-month intervals with the California First-Year Mental Scale (1). From 15 through 60 months they were tested (first at three -- and later at six-month intervals) on the California Preschool

Scale I (8). At 66 months they were given a vocabulary test from the Thorndike CAVD and a series of form boards. At 72 months they were given the Stanford-Binet. At all visits, from one through 72 months, they have been scored on a series of motor tests. The motor tests for the first three years have been standardized and published under the title of "The California Infant Scale of Motor Development" (University of California Press, Berkeley, California); similar tests, involving both gross physical abilities and fine motor coordinations, have been adapted for use at later ages.

TABLE 5

Coefficients of Reliability of Mental and Motor Tests for the First Six Years

(Split-half correlations with Spearman-Brown correction)

Age in Months	No. of Cases	r for Mental Test	r for Motor Test
1+2+3	52	.84	.76
4+5+6	54	.95	.82
7+8+9	45	.94	.82
10+11+12	50	.89	.93
13+14+15	45	.85	.88
18	51	.93	.83
21	53	.83	.76
24	48	.80	.74
27	51	.88	.82
30	47	.89	.82
33	44	-*	.86
36	49	.84	.80
42	43	.92	.83
48	45	.94	.71
54	44	.96	.86
60	47	.95	.94
66	46	-*	.91
72	46	.81	.88

*No mental tests were given at 33 or 66 months.

The reliabilities of the mental and motor tests are given in Table 5 for ages up to six years. (Group B) For the first 15 months the reliability of a single test is unsatisfactory; this difficulty has been overcome by combining the results for three successive tests.

4. THE ENVIRONMENTAL DATA

The environmental data utilized here were obtained by an experienced social investigator (Miss Frances Welch) who visited the homes and interviewed the parents (usually the mother) in the first month or two after the child's birth. The information obtained includes the years of schooling of the mother and the father, the father's occupation, his earnings, the total family income, and descriptions and ratings of the house exterior, living room, home furnishings and equipment, and the neighborhood. These ratings of home and neighborhood are based upon the Berkeley Social Rating Scale.[1]

Table 6 presents intercorrelations of the principal environmental measures; Group B and, for purposes of comparison, a random selection from Group A, are represented. The two samples agree in indicating a substantial degree of interrelationship among the various factors considered. Husbands and wives are

[1] Reliability, validity, and intercorrelations of the elements in this scale are presented elsewhere, (11).

TABLE 6*

Inter-Correlations Between Various Socio-Economic Measures

GROUP A (n = 145)

	Income	Mother's Education	Father's Education	Occupation
Composite Social Rating	.79	.56	.58	.62
Family Income		.50	.54	.68
Mother's Education			.75	.63
Father's Education				.71

GROUP B (n = 52)

	Income	Mother's Education	Father's Education	Occupation
Composite Social Rating	.82	.37	.57	.69
Family Income		.24	.59	.70
Mother's Education			.56	.57
Father's Education				.80

*The composite social rating is based on a sum of five 5-point ratings of house exterior; neighborhood, living room family accommodations and special equipment. In order to obtain linear regression lines, correlations for income were based on auxiliary scores in terms of the following logarithmic scale values:

Scale	Annual Income	Scale	Annual Income
1	\$ 792 - \$ 937	9	\$3060 - \$3619
2	937 - 1109	10	3620 - 4389
3	1110 - 1309	11	4390 - 5079
4	1310 - 1559	12	5080 - 6009
5	1560 - 1839	13	6010 - 7129
6	1840 - 2179	14	7130 - 8439
7	2180 - 2589	15	8440 - 10,000
			Over 10,000

Occupation was scored in terms of the Taussig rating of father's occupation.

assortatively mated with regard to educational level; higher educational level is associated with higher occupational status, higher income, and higher socio-economic rating as to home and neighborhood. The highest correlations are between income and social rating, income and occupation, and father's education and occupation. From these coefficients, of course no inferences can be drawn as to direction of causation. In general, the two samples show similar values as to intercorrelation, with the exception that in Group B, mother's education tends to be somewhat less closely associated with the other variables than is the case in Group A.

An additional factor to be considered in interpreting the inter-relationship of socio-economic measures, as well as their relation to other variables, is the factor of chronological age. In Group B, the age of the father is correlated .26 with the composite social rating, and .37 with family income. Age of mother is correlated .39 and .38, respectively, with these variables, and .79 with age of father. The mean age of father (at the birth of the child) was 31.8 years, with an S.D. of 6.5. The mean age of mother was 28.4, with an S.D. of 6.2.

The factors listed in Table 6 have been combined into a total socio-economic score. The weightings of the factors are, approximately: Composite social rating, 1/3; family income, 1/4; occupation of father, 1/5; midparent education, 1/6.[1]

[1]These weightings were obtained by (a) summing the social ratings, with weighting of 1 (b) computing logarithmic scale scores for income, with weighting of 1 (c) multiplying Taussig rating of father's income by 2 (d) summing years of schooling of father and mother, and dividing by 4.

5. THE RELATIONSHIPS OF SOCIO-ECONOMIC VARIABLES TO MENTAL AND MOTOR STATUS AT SUCCESSIVE AGES

The different measures of socio-economic status -- parent's education, occupation, income, composite social rating, and the total socio-economic score -- have been correlated with the developmental scores of the children in Group B for all ages tested. The correlations with mental development are given in Table 7. A study of this table shows that for the first 18 months all *r*'s are either close to zero or tend to be negative. After this age some of the environmental factors develop a positive relation to mental scores while others remain only slightly related. Although the differences between single *r*'s are often not significant, the consistency of the trends for successive ages indicates that, for this particular sample, certain differences do hold. After the relationships become positive the highest *r*'s are with the mother's education (See Figure 1), reaching .5 at two years. Similar correlations with father's education are not found

TABLE 7

Relation of Child's Mental Score to Different Socio-Economic Measures

Age in months	N	Number of Years Mothers' Education	Number of Years Fathers' Education	Mid-Parent Educ.	Fathers' Occupation	Family Income	Social Rating	Total S.E. Scale
1+2+3	50	-.15	-.07	-.14	-.12	.12	.24	.12
4+5+6	50	-.23	-.26	-.29	-.26	-.02	.03	-.10
7+8+9	49	-.01	-.09	-.08	-.05	-.09	.06	-.04
10+11+12	47	.06	-.06	.02	.01	-.05	.07	.05
13+14+15	45	.03	-.11	-.01	-.09	-.03	.04	-.10
18	44	.12	-.10	.16	-.06	-.07	-.05	-.10
21	46	.37	.19	.29	.16	.04	.18	.15
24	41	.52	.39	.50	.35	.20	.29	.34
27	44	.47	.21	.41	.27	.10	.28	.25
30	41	.48	.33	.44	.25	.08	.19	.20
36	43	.46	.28	.47	.23	.00	.16	.04
42	37	.46	.26	.38	.30	.07	.15	.18
48	39	.50	.37	.50	.31	.11	.13	.22
54	38	.40	.39	.50	.43	.19	.12	.26
60	40	.48	.53	.58	.43	.27	.26	.36
72	42	.58	.50	.59	.38	.32	.29	.41

until the age of 5 years. Figure 2 gives the *r*'s at successive ages for the different items used in the total socio-economic scale. Mid-parent education is seen to be most highly related to mental scores, and family income least, with the total socio-economic score falling somewhere between in its relationship. There is, in this group, a trend toward increasing correlation between mental performance and the various socio-economic factors which have been compared; correlations with income and social rating reach a peak at about .3, and with occupation and with the total socio-economic score at about .4. It may be noted that the Stanford-Binet (at 6 years) shows on the average about the same degree of relationship to socio-economic variables as the California Preschool Mental Scale at 5 years.

Turning to the data for motor abilities, Table 8 indicates a much lower degree of relationship between socio-economic variables and this phase of development, than was found in the case of mental scores.[1] Correlations with mother's education, although low, are fairly consistently positive. Correlations with father's

[1] Correlations after 54 months have not been computed with the motor scores as there was no evidence of directional trends in relationships.

FIGURE 1
CORRELATIONS WITH MENTAL SCORES.

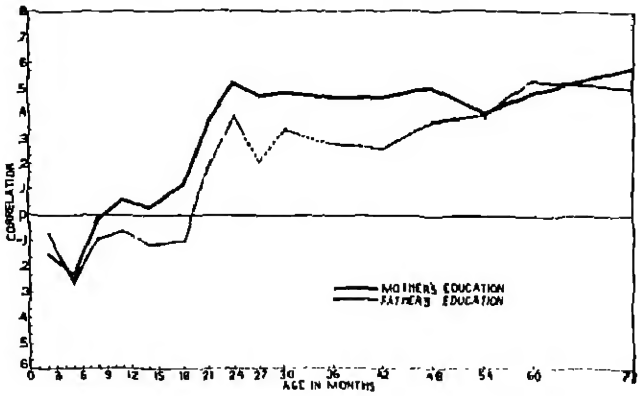
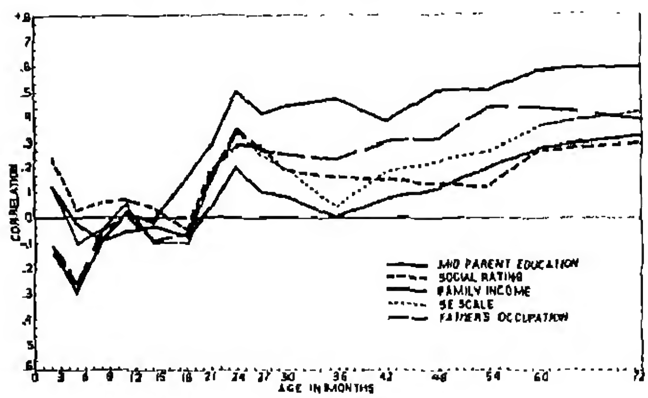


FIGURE 2
CORRELATIONS WITH MENTAL SCORES



education, and with the family income are close to zero throughout. With the composite social rating and with the total socio-economic scale there is some suggestion of an increasing trend between 15 and 30 months, but none of the coefficients are significantly different from zero. The age of first walking and of first talking also fail to show any relation to the socio-economic variables considered here (Table 9).

As in the case of the mental scores, it is interesting to note the high incidence of slightly negative correlations with motor scores during the first year of life, suggesting the possibility of more rapid early mental and motor development among children from inferior socio-economic groups. If subsequent studies show that significance should be attached to these negative relationships, it would be interesting to explore two possible lines of explanation, (1) in terms of a biological hypothesis that within the human species as well as when human and infra-human species are compared, precocity in infant development is associated with a lower limit of development, (2) in terms of an environmental hypothesis that children from economically inferior homes tend to experience a regime more

TABLE 8

Relation of Child's Motor Score to Different Socio-Economic Measures

Age in Months	N	Number of Years Mothers' Education	Number of Years Fathers' Education	Mid-Parent Educ.	Family Income	Social Rating	Total S.E. Scale
1+2+3	50	.09	.21	.16	.26	.32	.27
4+5+6	50	-.16	-.34	-.14	.02	-.01	-.10
7+8+9	49	.08	-.19	-.01	-.12	-.02	-.12
10+11+12	47	.20	-.15	-.04	-.25	-.06	-.12
13+14+15	46	.29	-.03	.08	-.18	-.10	-.12
18	44	-.04	.01	.10	.09	.18	.12
21	46	.10	.00	.29	.09	.11	.07
24	41	.26	-.03	.11	.03	.23	.13
27	44	.14	-.13	-.02	.10	.20	.14
30	41	.17	.03	.08	.09	.25	.19
33	39	.35	.08	.21	.01	.28	.20
36	43	.22	-.01	.14	-.17	.08	.01
42	36	.12	-.14	-.03	.07	.17	.05
48	39	.15	-.09	-.04	-.11	.13	.00
54	39	.20	-.03	.12	-.14	.06	.01

TABLE 9

Correlations of Age at First Talking and Walking with Socio-Economic Variables

	Age of First Walking Alone		Age of First Saying Two Words	
	No. of Cases	*r*	No. of Cases	*r*
Mother's Education	55	-.09	53	-.22
Father's Education	55	+.03	53	-.19
Mid-parent Education	55	-.04	53	-.24
Family Income	48	+.15	46	+.01
Social Rating	55	-.03	53	-.05
Total S-E Scale	53	+.08	51	-.13

stimulating to motor-adaptive behavior, while children from superior homes are in infancy more sheltered and cared-for and have less incentive for independent action.

Of the correlations presented in Tables 7, 8, and 9, the highest are those between parent's education and the children's mental performance. In accounting for this relationship, consideration must of course be given to both educational and genetic factors. Similarly, the increase in correlations, from one to three years, may be due to the cumulative influence of educational factors, or to the delayed maturation of hereditary characteristics or to varying contributions of each. Our data cannot at present be utilized to distinguish between those nature-nurture variables, or to define their relative importance at successive ages. A possible clue to be followed in subsequent investigation may be found in the tendency for the child's mental scores to correlate higher with mother's education than with father's education. This cannot readily be explained on a genetic basis, but (in view of the greater association of the mother with the child) would be expected if the resemblance between parent and child is primarily nurtural. It is possible, of course, that the difference in correlation is a chance characteristic of this small sample. Similar results, however, have been shown elsewhere.[1]

[1]In an earlier study of the relationship of the mental test scores of parents and children, among children principally of school age, Jones (9) found slightly higher mother-child than father-child correlations. Both Goodenough (7) and Van Alstyne (12) report *r*'s for test scores of preschool children which are slightly higher with the mother's education, though in some instances the differences are very small.

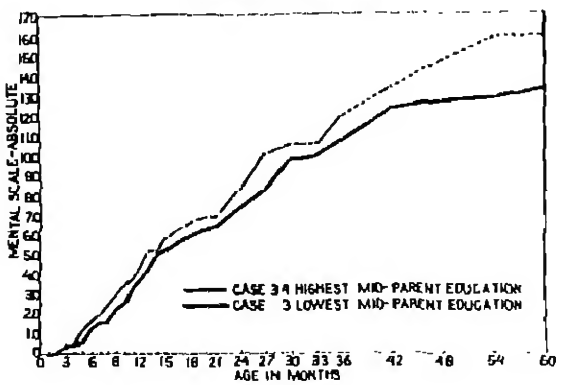
Another line of approach is through the comparison of parent-child correlations in the case of different types of mental performance; the problem here is to discover whether higher coefficients of resemblance are found in the case of abilities which are more likely to be influenced by training. One such comparison has been made on this group for tests given at five and a half and six and a half years. Three form boards (the Four-figure, Two-figure, and the Casuist) were given at these ages, and scored according to Arthur's standardization. The three scores were then summed to make a single form-board score. At five and a half years, levels A, B, C, D, E, F, and G of the Thorndike CAVD were given. At six and a half years a shortened series of the CAVD vocabulary was used -- level D, and five items from each of levels E, F, and G.[1]

The form-board scores correlated .45 and .33 with mid-parent education at 66 and 78 months, respectively; while the corresponding correlations for vocabulary are .33 and .39. A correlation coefficient (.41) has also been computed at 6 years between Stanford-Binet Vocabulary and mid-parent education. From these correlations, no case can be made out for a greater environmental influence on a verbal test than on a non-verbal test, although the latter would be expected to be less affected by social-cultural factors in the home.

6. ANALYSIS OF GROWTH CURVE DATA

A selection was made of two groups of children whose parents have the highest and the lowest education scores in sample B. Nine children are included from the high education category, and 8 from the low education group. Figures 3, 4, and 5 present a comparison of mental growth curves for children whose parents differ most in education. Each curve represents a child's scores, obtained by the Thurstone method of absolute scaling, for each age he was tested, from month one through month sixty. In these figures the compared curves are intersecting or close together during the first 12 or 18 months, after which the child from the superior group forges ahead. By way of contrast, Figure 8 presents the mean

FIGURE 3
INDIVIDUAL CURVES
HIGH AND LOW EDUCATION



[1] As the children were unable to read, it was necessary to modify the procedure with Levels E, F, and G, and administer these tests orally.

FIGURE 4
INDIVIDUAL CURVES
HIGH AND LOW EDUCATION

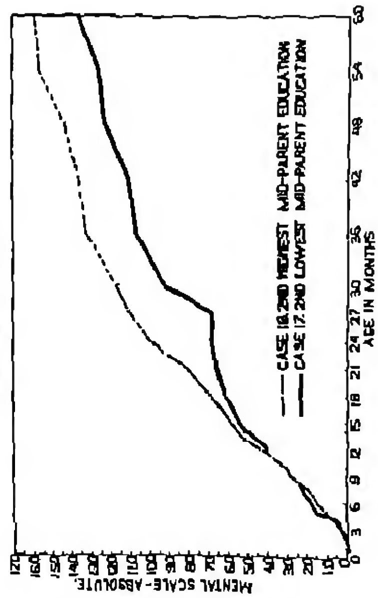


FIGURE 5
INDIVIDUAL CURVES
HIGH AND LOW EDUCATION

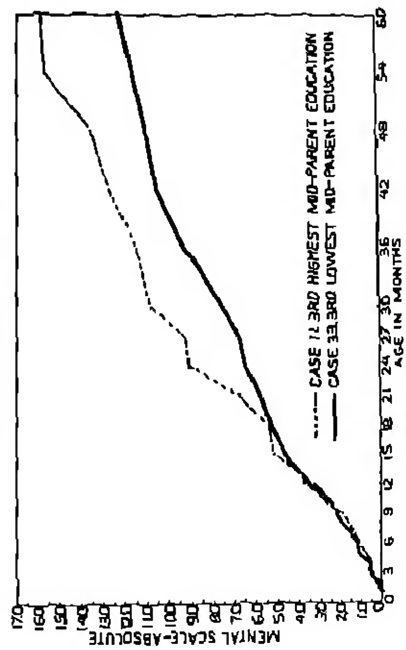


FIGURE 6
MEAN CURVES OF FIVE PAIRS OF SIBLINGS

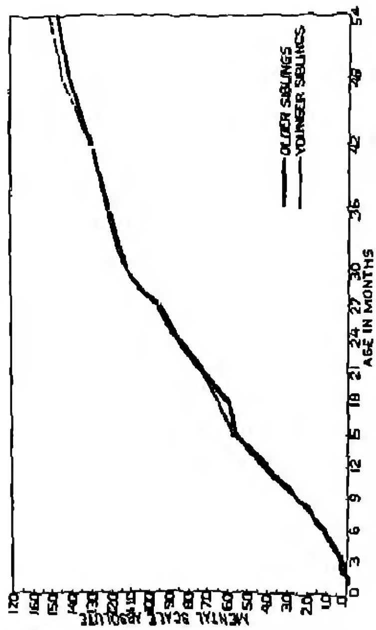
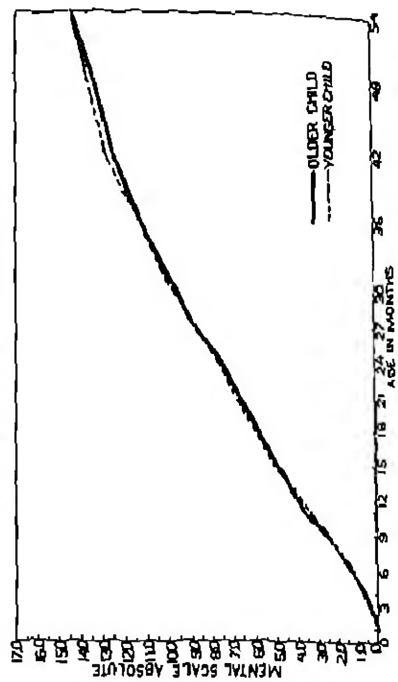


FIGURE 7
MEAN CURVES OF 13 UNRELATED PAIRS
MATCHED FOR MID-PARENT EDUCATION



curves of five pairs of siblings who have been studied, and Figure 7 presents the means of 13 pairs of unrelated children who have been matched for mid-parent education. In these cases, the two sets of curves are practically superimposed. The graphic data confirm the results of correlational analysis, in showing, after about 18 months of age, an increasing correspondence between a child's mental scores and the social-cultural-economic position of his home. It is obvious, however, that neither the correlations nor the growth curves can do more than present a preliminary descriptive account of relationships. We must turn to other methods if an explanation of these relationships is required, and if we are to gain a more precise prediction and control over the phenomena involved.

From previous work, the hypothesis has emerged that test performance during the first eighteen months is not diagnostic of intellectual ability. This is based partly on the greater community of function found between motor and mental scores in infancy (correlations are of the order of .5 during the first fifteen months, after which age the relationship drops markedly (2)). More directly pertinent is the fact that early mental test performance is uncorrelated with mental scores made after two years, even when a selection of the most "intellectual" items is used for comparison (2). This emphasizes the fact that the increasing correspondence between mental score and environmental variables is not necessarily attributable to the influence of the environment; it may equally well be a phenomenon of infant development, that inherited parent-child resemblances become evident only after a certain stage in the process of maturation has been reached. Evidence can be adduced in favor of each of these interpretations; the probability is that each has some validity, and that the growth of children involves both an increasing assimilation of environmental pressures and an increasing manifestation of complex hereditary potentialities. The extent to which these factors interpenetrate, and their relative importance, cannot be stated in general terms, since the answer must vary according to the function involved, the age level, and the central tendency and variability of each set of impinging factors.

SUMMARY

1. In a group of 59 families in which children were born in 1928-29, a social investigator collected data on parents' education, family income, father's occupation, and social-cultural-economic factors represented in the Berkeley Social Rating Scale.

2. During infancy the children of this group were given the California First Year Mental Scale monthly to fifteen months; the California Preschool Scale I was administered twelve times from eighteen to sixty-six months, and the Stanford-Binet at six years. Reliability coefficients are presented for each age level.

3. In the test group, and in a larger more representative Berkeley sample, the various socio-economic factors showed inter-correlations ranging for the most part between .5 and .8.

4. All the factors considered show zero or slightly negative correlations with mental test scores to 18 months of age. Coefficients increase thereafter.

5. The single factor showing the highest correlation with mental tests scores is mother's education, reaching a peak of .5 at two years of age. Father's education reaches a correlation of .5 at five years of age.

6. Among the socio-economic factors correlations of mental scores with

father's occupation increase to almost .4 at four and a half years; with income and with the composite social rating, correlations increase to about .3 at 6 years.

7. With a total socio-economic scale, mental scores show a correlation increasing from -.10 at eighteen months to .41 at six years.

8. A battery of motor tests was given at monthly, 3-month, and 6-month intervals from one month of age to six years. Correlations with environmental factors are lower than in the case of mental scores.

9. Motor scores tend to correlate positively with mother's education, approaching a peak of about .3 between fifteen and thirty-three months.

10. Father's education and family income show no relation to motor scores. The composite social rating shows a slight relation to motor scores, increasing from -.10 at fifteen months to .28 at thirty-three months and declining thereafter. Although probable errors are high in this material, attention is called to age trends in the correlations.

11. Age of first walking alone, and age of first saying two words, show no relation to environmental factors.

12. A comparison was made of environmental correlates for different types of mental performance. Both vocabulary scores, and form-board scores were shown to correlate about .4 with mid-parent education.

13. The correlational analysis for mental test scores is supported by individual growth data (mental growth curves in absolute units) for children from homes of contrasting educational status. Theoretical implications are discussed.

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SEX DIFFERENCES IN BEHAVIOR OF NURSERY SCHOOL CHILDREN

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The old age problem "Which comes first, the chicken or the egg?" appears to be no more interesting nor baffling than the question of sex differences. "Are there observable and significant differences in the behavior of boys and girls? If so, can these differences be attributed to variations in social training and attitudes or do they represent fundamental, innate differences in function or structure? These are questions which are almost as puzzling today as they were thirty years ago when research investigations on sex differences were in their beginnings.

On the latter of these two questions information is especially vague. No verifiable data on innate differences in behavior exist. We have only the belief that such differences are possible. To quote Murphy and Murphy, "Even on the endocrine evidence alone some qualitative sex differences seem beyond all doubt." (28, p. 122)

On the first of the two questions we do have a smattering of knowledge, assembled from countless studies. The majority of these studies have, in themselves, yielded negative or negligible results. It is largely because so many studies have shown the same consistent tendencies that we are justified in thinking that some sex differences in behavior do exist.

Most of the information which is available on sex differences is based upon studies of school age children or adults, upon whom social forces may have exerted a strong influence. The available data on preschool children -- in whom social factors have had considerable, but obviously less opportunity to operate -- is limited to studies which in themselves have dealt primarly with very restricted or isolated aspects of behavior.

The present investigation is based upon ratings for a wide variety of behavior tendencies in children of preschool age. A description of the data is given in the following section. The analysis of the data involved not only generalized comparison of the behavior of boys and girls, but also an analysis in terms of age level. The latter comparisons were made in the hopes that age differences in sex comparisons might throw some light on the problem of innate versus socially conditioned factors.

Source of Data

The subject of the investigation were 283 boys and 296 girls enrolled in the Winnetka Public School Nursery and in the W.P.A. Nursery Schools of Chicago, operating under the Chicago Board of Education. A previous investigation (16) gives a partial picture of the home backgrounds of these children. The age distribution follows:

Sex	Frequency						
	Age Groupings						Totals
	2	2½	3	3½	4	4½	
Boys	10	34	74	90	52	15	283
Girls	13	40	89	93	52	9	296
Totals	23	74	163	191	104	24	579

[1] From Winnetka Public School Nursery.

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The children were rated on a specially devised form containing 60 behavior items indicative of routine habits and personality adjustments. The items were classed under the following headings: (1) eating habits, (2) sleeping habits, (3) enuresis, (4) nervous habits, (5) speech difficulties, (6) fears, (7) reaction to adults, (8) reaction to children, (9) other reactions. Each child was rated in terms of the frequency with which a particular type of behavior had occurred in the past month: (1) "never", (2) "less than once a week", (3) "once a week", (4) "several times a week", (5) "daily or more". A particular child's score on a given type of behavior was the average of three independent judgments made by teachers in daily contact with the child.

Reliability of Data

A previous report (18) contains an account of the reliability and validity of the first 335 records obtained. The median reliability of these ratings (determined by comparing judgments by the same teacher on the same child one week apart) was found to be 85 per cent and the median agreement on the validity measure (determined by comparing a given teacher's judgment on a child with the average judgment of the three raters) was found to be 89 per cent.

The data were collected in two different years, the first set of records containing data on 335 boys and girls, the second set of records containing data on 244 boys and girls. The rank correlation found on the 60 behavior items for boys, when the first set of records were compared with the remaining set was .93 + .01. The rank correlation for girls on this same comparison was .92 + 13. These findings meet the usual requirements expected of reliability measures.

Analysis of Data

The data were analyzed separately for any occurrence of the behavior and for habitual occurrence (the latter term being used to designate behavior occurring "several times a week", "daily or more"). Critical ratios were determined only for the former analysis (any occurrence) since this contained the greater number of cases.

THE FINDINGS

Behavior Characteristic of Nursery School Boys

Table 1 contains all the behavior which was found more frequently in boys than in girls. As an aid to the reader in making interpretations, the findings have been arbitrarily grouped under the headings Reaction to children, Reaction to adults, Speech habits, Work habits and Other overt behavior patterns. In the discussion a still more generalized classification has been used.

Aggressive Extroverted Behavior

The most outstanding characteristic of the table is the prevalence of aggressive, extroverted types of behavior. Such behavior takes several forms. It is reflected, for instance, in (1) aggressive approaches to other children, (2) negativism toward adults, (3) marked physical activity and (4) non-social behavior problems of an overt type.

In their approaches to other children boys showed more grabbing of toys and more attacking than did the girls. The differences are so close to significance

TABLE 1

Behavior Tendencies Most Frequent in Boys of Preschool Age

Behavior	% Marked Occurrence		Occurrence to Any Degree Percentage		Critical Ratio[1]	Chances in 100
	Boys	Girls	Boys	Girls		
Reaction to Children						
*Grabs toys	.20	.12	.67	.53	-2.60	99
*Attacks others	.15	.05	.60	.44	-2.76	100
Refuses to share	.16	.11	.67	.60	1.37	92
Takes property	.03	.03	.32	.26	0.84	80
Reaction to Adults						
Refuses to Comply	.21	.15	.70	.64	1.25	89
*Ignores Requests	.32	.19	.79	.72	1.70	96
*Hard to reason	.18	.13	.50	.53	0.91	82
Resists at rest	.25	.18	.63	.60	0.59	72
Work Habits						
Asks unnecessary help	.22	.16	.79	.66	-2.04	100
*Wastes time	.33	.26	.83	.76	1.71	96
*Leaves work incomplete	.29	.23	.83	.81	0.57	72
Speech						
Stutters	.06	.04	.25	.13	1.50	93
Lisps, lalls	.16	.16	.39	.37	0.30	62
Slurs, speaks indistinctly	.27	.21	.52	.40	0.67	74
Other Overt Behavior						
Wriggles when sitting	.26	.22	.72	.65	1.46	93
*Laughs, squeals, jumps around excessively	.27	.18	.68	.51	-3.21	100
*Tense at rest	.15	.10	.60	.48	2.07	98
Stays awake during nap	.19	.12	.57	.43	2.00	90
*Breaks toys	.03	.01	.34	.20	2.04	98
Temper outbursts	.06	.01	.31	.28	0.41	65
*Rushes into danger	.08	.04	.48	.27	-3.21	100
*Handles sex organs	.06	.02	.34	.31	1.90	97
TOTAL CASES	283	296	283	296		

[1] Based on standard errors from nomographs in Dunlap and Kurtz, World Book Co., 1932, Pp. 163 (p. 17, 25)

*These traits also showed a consistent tendency to occur more frequently in boys when analyzed at half year intervals.

(99 and 100 chances in 100 respectively) that they would in all probability be found again in a similar sampling. In refusing to share boys also exceeded the girls (92 chances in 100). In fact, in only one aspect of behavior, bossing of others, (Table 2) did girls show the more aggressive tendency. The difference here is slight, there being only 82 chances in 100 that it would be found again. It is interesting to note that bossing involves more verbal than physical directing, and hence the girls' superiority in speech in contrast to boys' superiority in physical activity might explain the tendency found.

In their reactions to adults, boys were predominately negativistic. This is reflected in such behavior as refusing to comply, ignoring requests, being hard to reason with, resisting at rest. The differences are not so marked as those noted in reactions to other children. (The chances of significance are 89, 96, 82, and 72 in 100 respectively). It seems important to note, however, that the differences point to greater negativism in the boys in the case of all but one of the negativistic measures used. The exception, refusal of foods, which was greater in girls (96 chances in 100), is a doubtful item to include in this category since it has seemed, from our own experience, to be as often prompted by a desire for attention or by genuine food idiosyncrasies as by a truly negativistic attitude.

The two measures of general activity used on the present scale were "wriggles

a great deal when sitting" and "laughs, squeals and jumps around excessively." In both of these boys exceeded the girls. The more frequent tenseness at rest and staying awake at naps which was found for boys may also reflect this general tendency toward active types of behavior.

Other non-social behavior problems displayed with greater frequency by the boys include "breaks toys", "takes property of others", "rushes into danger" and has "temper outbursts". It is practically certain (98 and 100 chances in 100 respectively) that boys would show more breaking of toys and more rushing into danger in another sampling of cases. The differences between boys and girls on the other two types of behavior are slight.

At this point it seems valuable to compare the present findings with earlier investigations on sex, regardless of age levels involved. It was virtually impossible to make such a comparison for the separate items listed above, and a rather generalized comparison has therefore been attempted. On this basis, agreement is marked. Marston (22) Guilford (11) and Hendrickson and Huskey (17) definitely report more extroverted tendencies in boys than in girls. Wickman (42), Olson (30), Haggerty (12), Cornell (8), Phillips (31), Blanchard and Paynter (3), Anderson (2), Blatz and Bott (4), Mathews (24), Martens and Russ (23), Mendenhall (25), Levy (21), and doubtless many others have found more boys than girls referred for help with behavior difficulties and tend to indicate that boys are probably referred to a greater degree because their problems are of an aggressive, overt type and are hence more apparent and annoying to adults than the problems presented by girls. Snyder (37), in a study of institutionalized cases, found considerably more instances of offense against property in boys than in girls. Nelson (27) as well as many of the other authors referred to above, has found that boys display more overt activity than do girls.

Only on the question of negativism does disagreement seem to exist. The studies by Levy and Tulchin (19, 20), which are accepted and quoted most often by authorities, revealed more "resistance" in girls than boys. Reynolds (32) did not attempt sex comparisons in the study of negativism. Rust (34) found an insignificant tendency toward greater negativism in girls during mental tests. Goodenough (10) and Nelson (27), also in mental test situations, found a tendency for greater negativism in boys.

It may be that much of this apparent disagreement would disappear if we would analyze more carefully the concepts of resistant and of negativistic behavior. It seems to the writer that there is a common tendency when we think of these reactions, to picture a child who is aggressively maintaining his own - and yet when we read such a study as that of Levy and Tulchin's we find that much of the resistance (in fact the greater part of the resistance of girls) was in the form of crying and withdrawing. If we would define our terms more carefully, and include in the concept of negativism only the aggressive, defiant type of behavior then the bulk of past studies as well as the present one would seem to indicate greater negativism in boys.

Work Habits

Undesirable work habits such as "asks unnecessary help", "wastes time at routines" and "leaves tasks incomplete" were found to be more common in boys than girls. The chances are practically certain (100 and 98 in 100 respectively) that the first two tendencies would hold in another sampling.

These findings have some verification in previous reports. Goodenough (10)

for instance, found boys more distractible than girls (this might account for both wasting time and leaving tasks incomplete) in mental test situations. Hartshorne and May (14) found girls more persistent than boys. Nelson (27) also found an insignificant tendency for girls to be more persistent while Chapman (7) found no sex difference in persistence in eighth grade pupils. In other types of behavior which reflect on habits of work and responsibility, such as self-control, responsibility for others, and memory ability girls have also been found superior.

The inferiority of boys to girls on work habits may be another aspect of the sex differences in introversion and extroversion noted in this report. Girls, for instance, with their more subjective attitudes (see following section) are more likely to be influenced by the opinions of others and might be more conscientious in their work for this reason.

For a real understanding of the above characteristics a more detailed study is obviously necessary. "Wasting time" for instance may occur because the child enjoys his daydreaming or it may occur because the child is actively distracted by things about him. If the distinctions indicated by this study hold, we would expect the first type of behavior to occur most frequently in girls and the second type in boys. The generalized concept of wasting time used in the present report conceals these finer distinctions.

Speech Habits

Boys showed slight tendencies to display more stuttering, lisping or lalling, and slurring or speaking indistinctly (the only three types of speech habits rated) than did girls. This is in full accord with findings of previous investigators. To quote from the summary of the literature by Wellman "In the early years girls are clearly ahead of boys in all aspects of language and speech development. In the investigations covered there was no instance where boys were superior, although a few reported no differences. These aspects include the age of beginning to talk, size of vocabulary, length of response, comprehensibleness of response, use of parts of speech, sentence structure, function of language, speech sounds and stuttering." (41, p. 631) Such general agreement seems to point rather definitely to a real sex difference in this group of traits at the preschool level. Whether these differences fade out as boys and girls reach a similar stage of maturity remains something of a question, though certain studies reviewed by Wellman (41) suggest that they persist.

Special Tendencies

Thirty-four percent of boys as compared with twenty-one percent of girls showed tendencies to masturbate. There are 97 chances in 100 that the difference is significant. The same tendency has also been noted by Olson (28) and Koch (18). It is rather generally recognized that the signs of masturbation in boys are more conspicuous than in girls hence that the above finding may be influenced by selective observation. On the other hand, physical structure might account for this difference just as it seems to account for the greater hair manipulation in girls. (Table 2).

BEHAVIOR CHARACTERISTIC OF NURSERY SCHOOL GIRLS

Table 2 contains the behavior tendencies which were most frequent in girls.

TABLE 2

Behavior Tendencies most Frequent in Girls of Preschool Age

	% Marked Occurrence		Occurrence to any Degree			
			Percentage		Critical[1] Ratio	Chances in 100
	Girls	Boys	Girls	Boys		
Reaction to Children						
*Avoids play	.12	.10	.52	.40	1.97	98
Gives in too easily	.09	.08	.62	.55	1.30	90
*Jealous	.03	.03	.40	.27	1.88	97
Reaction to Adults						
*Shrinks from notice	.10	.04	.38	.34	0.66	74
*Seeks praise	.25	.14	.71	.66	1.04	84
*Stays near adult	.15	.06	.67	.41	4.50	100
*Criticizes others	.16	.09	.71	.66	1.04	84
Other Withdrawing Introverted Tendencies						
Dawdles at meals	.41	.36	.70	.68	2.04	98
*Sucks thumb, day	.11	.07	.43	.31	1.69	95
*Fears strange people, places	.05	.04	.40	.33	1.04	84
*Fears high places	.12	.06	.53	.42	1.85	97
*Cries easily	.16	.15	.67	.59	1.54	93
*Avoids risk	.23	.10	.66	.57	1.73	96
*Tells fanciful stories	.05	.06	.40	.34	0.88	81
*Misrepresents facts	.04	.00	.26	.20	0.76	77
Sulks	.15	.09	.56	.54	0.36	64
Other General Tendencies						
*Refuses food	.19	.13	.66	.56	1.79	96
*Twists hair	.11	.04	.57	.37	3.28	100
*Bosses others	.17	.13	.60	.55	0.91	82
TOTAL CASES	296	283	296	283		

[1] Based on standard errors from nomographs in Dunlap and Kurtz.

*These traits also showed a consistent tendency to occur more frequently in girls than boys when analyzed at half year intervals.

It will be seen that the general picture here is quite the opposite from that presented by Table 1.

Withdrawing, Introverted Tendencies

The behavior listed in Table 2 is predominately of a withdrawing, introverted type. Whether it be in contacts with other children, in relationship to adults, or in general non-social behavior patterns this tendency is apparent.

Girls, more than boys, tend to "avoid play with other children" and to "give in too easily". There are 98 and 90 chances in 100 respectively that these differences would be found again.

In relation to adults, girls, more than boys, tend to "shrink from notice", "seek praise", "stay near adults", and "go to adults with criticism of others". The difference is significant for "stays near adults", but only slight for the other types of behavior.

No less interesting than the above findings is the fact that all but three of the remaining types of behavior which are predominant in girls are examples of withdrawing or introverted tendencies. This behavior includes dawdling, thumb-sucking, fears, jealousy, crying easily, avoidance of risk, telling of fanciful stories and misrepresenting facts. Although the differences are extremely slight, daydreaming and sulking have also been added to the table since they do reflect the tendencies just described.

Isolated findings from other studies support the tendencies listed above. Although most of the studies on jealousy -- see Foster (9), Sewall (35), Smalley (36), Ross (33), -- revealed statistically insignificant sex differences the trend

was for greater jealousy in girls. Levy and Tulchin (20), Terman (38) and others have reported girls or women more shy and withdrawing. Terman (38) and Snyder (37) have found that girls show more tendencies toward fears. Snyder (37) reports more dream life in girls. Wickman (42) Mareton (22) Guilford (11) and others report more withdrawing, introverted tendencies in general in girls than in boys.

<u>Special Tendencies</u>

Twisting of hair is one of the few traits which is significantly more frequent in girls than in boys. This tendency has been noted by both Olson (28) and Koch (18). It, like handling of sex organs, is undoubtedly conditioned in part by physical structure -- i.e. girl's hair is longer and hence liable to be a more disturbing factor than is the hair of boys. Further investigation is needed to determine to what extent hair twisting is motivated by local irritation and to what extent it may be considered on a par with other so called nervous habits.

The tendency toward greater refusal of food in girls has already received comment. The general constellation of traits with which food refusals are associated seems, to the writer, to afford some evidence that this behavior is more closely allied to withdrawing or attention seeking than to the more aggressive negativistic tendencies. Data from a forthcoming study on inter-correlations between the 60 behavior items studied give further support to this supposition.

The tendency for girls to do more bossing of others than boys has also received comment. While the tendency is only slight it seems a logical expectancy in a group which has superior language development and which in general turns away from physically active types of contact. Boys in other words probably do less bossing because they manage other children in more direct physical ways.

<u>Behavior Unrelated to Sex</u>

Of all the behavior analyzed for the present report only two general types remain for discussion: (1) wetting (day and night) and (2) nervous tendencies (bites nails, chews objects, plays with fingers, picks nose, twitches, holds body tense). Neither group has revealed sex relationships.

Wetting has never stood out as a sex characteristic and seems to need no further comment. Nervous tendencies, on the other hand, have frequently been investigated for the possibility of sex differences. While the majority of studies give a faint suggestion that girls are less stable and probably more subject to nervous habits (41) than are boys, the one most thorough study of such tendencies at the preschool level, Blatz & Ringlund (5), has indicated that sex is not a factor. It seems probable that here, as in the case of negativism, we will find more general agreement after we have reached a common understanding as to what does and does not constitute a nervous trait. The findings in regard to handling of sex organs and to twisting of hair, for instance, suggest that within the now commonly accepted list of nervous symptoms differential factors are operating, and that these will need to be understood before too many generalized statements are made.

<u>Age Differences in Behavior of Nursery School Boys and Girls</u>

When boys and girls are compared at half year levels (2, 2½, 3, 3½, 4 and 4½) instead of in the broader grouping, do the above tendencies still hold? Do the differences tend to increase or decrease between the ages of 2 and 4? An age

comparison was attempted in order to provide an answer to these questions.[1]

Age Comparison of Behavior Showing Greater Occurrence in Preschool Boys

In the age comparisons the following traits all tended to be greater for boys than girls at 2½, 3, 3½ and 4. (Table 3):

- attacking others
- breaking toys
- grabbing toys
- handling sex organs
- hard to reason with
- ignoring requests
- laughing, squealing and jumping around excessively
- leaving tasks incomplete
- rushing into danger
- tenseness at rest
- wasting time at routines

Deviations in this trend at 2 and 4½ are not significant in lieu of the small sampling of cases at these two levels.

TABLE 3

Age Differences in Behavior Starred in Table 1
(Traits more common in Boys than Girls according to the total data)

Behavior	% Showing Behavior To Any Degree: Boys	To Any Degree: Girls	Habitually: Boys	Habitually: Girls
Attacks Others				
2	.60	.61	.30	.15
2½	.62	.48	.18	.05
3	.57	.37	.16	.03
3½	.80	.47	.12	.06
4	.60	.46	.13	.04
4½	.60	.44	.07	.22
Breaks Toys				
2	.50	.36	.22	.08
2½	.35	.30	.03	.03
3	.42	.26	.01	.01
3½	.34	.14	.04	.00
4	.31	.13	.02	.00
4½	.07	.11	.00	.00
Grabs Toys				
2	.60	.69	.10	.15
2½	.74	.73	.35	.22
3	.71	.51	.18	.11
3½	.61	.46	.19	.08
4	.65	.60	.13	.08
4½	.60	.56	.13	.22
Hard to Reason				
2	.60	.69	.30	.15
2½	.68	.58	.21	.20
3	.55	.52	.16	.10
3½	.54	.54	.16	.13
4	.56	.46	.15	.12
4½	.53	.44	.20	.11
Handles Sex Organs				
2	.20	.15	.00	.08
2½	.38	.25	.06	.00
3	.39	.24	.08	.03
3½	.30	.20	.07	.00
4	.40	.19	.06	.02
4½	.40	.00	.00	.00
Ignores Requests				
2	1.00	.54	.30	.15
2½	.88	.80	.41	.25
3	.82	.69	.30	.20
3½	.75	.74	.29	.20
4	.75	.75	.27	.10
4½	.73	.67	.27	.33

Behavior	% Showing Behavior To Any Degree: Boys	To Any Degree: Girls	Habitually: Boys	Habitually: Girls
Laughs, Squeals				
2	.40	.69	.10	.15
2½	.62	.58	.15	.13
3	.69	.55	.34	.18
3½	.69	.49	.32	.21
4	.71	.42	.27	.16
4½	.67	.89	.13	.33
Leaves Work Incomplete				
2	.90	.77	.30	.08
2½	.91	.90	.60	.35
3	.89	.79	.45	.29
3½	.81	.79	.17	.20
4	.79	.83	.21	.13
4½	.73	.89	.07	.11
Rushes into Danger				
2	.56	.38	.11	.00
2½	.47	.35	.18	.05
3	.57	.21	.05	.06
3½	.43	.28	.05	.01
4	.48	.29	.10	.04
4½	.20	.11	.07	.00
Tense at Rest				
2	.50	.61	.10	.00
2½	.78	.35	.21	.08
3	.53	.52	.16	.11
3½	.61	.59	.13	.09
4	.62	.52	.14	.12
4½	.46	.56	.23	.44
Wastes Time				
2	1.00	.77	.10	.08
2½	.88	.75	.47	.38
3	.91	.75	.44	.33
3½	.80	.77	.26	.24
4	.81	.83	.27	.19
4½	.60	.78	.07	.22

[1] Due to the limited number of 2 and 4½ year olds this comparison is most valid at 2½, 3½ and 4.

stuttering, lisping and slurring and refusing to comply were not more common in boys than girls until three years of age, but were consistently more frequent in boys than girls thereafter. Other characteristics listed in Table 1 did not reveal a consistent pattern when compared for sex-differences at successive ages.

Age Comparison of Behavior Showing Greater Occurrence in Preschool Girls.

In the age comparisons the following traits tended to be greater for girls than boys (Table 4) at all levels except 2 and 4½ (levels with an inadequate sampling of cases):

avoiding risk	refusing food
avoiding play with others	shrinking from notice
bossing	sucking thumb
criticizing others	staying near adults
crying easily	twisting hair
fearing strange people	telling fanciful stories
fearing high places	seeking praise
jealousy	misrepresenting facts

Giving in too easily and dawdling were not more common in girls than boys before three. They continued to be greater in girls than boys at 4½.

Sulking was the only trait in Table 2 which revealed a more irregular pattern at consecutive age levels than those traits just described.

Seen in toto, most of the behavior listed in Tables 1 and 2 already revealed sex differences as obviously at 2 or 2½ as at 3, 3½ or 4 years of age. The differences did not vary enough between these ages to justify the belief that sex differences increase or decrease from two to four. These findings lend support, however slight, to the belief that other factors than social conditioning have helped to make for the differences in the behavior of girls and boys.[1]

In opposition to this point, it should be remembered that the study does not extend below two years of age and that social conditioning is known to be a potent determinant of behavior in infancy and even before birth. While this is true it must also be remembered that the child makes his greatest social strides between 2 and 4. The two year old is still a self centered individual who plays primarily alone. The 4 year old is not only significantly more interested in doing things with people but is also much more conscious of people's opinions and attitudes than is the younger child. It would seem logical to expect -- if social forces were the primary causes of these sex differences -- that such differences would become observably greater between the ages of 2 and 4.

From a purely physical standpoint, it may be that differences in speed of response or in physical prowess underlie the sex differences noted in behavior. It _is_ recognized that boys excel girls not only in strength but also in speed of reaction -- i.e. in ability to mobilize their energy quickly. It is not difficult to see how the individual who more quickly responds to stimuli might be the more extroverted in his behavior. Certainly this possibility is worth considera-

[1] Neither do sex differences appearing after 2½ necessarily seem the result of social conditioning. Speech problems stand out at a later age in all probability because they are dependent upon development and regular use of language function. Refusals to comply may not stand out before three for the same reason. At least the general negativistic pattern (see ignoring requests and hard to reason with) is already more common in boys than girls at 2½ or 2.

TABLE 4

Age Differences in Behavior Starred in Table 2
(Traits more common in Girls than Boys
according to the total Data)

Behavior	% Showing Behavior To any Degree Boys	To any Degree Girls	Habitually Boys	Habitually Girls
Avoids Play				
2	.70	.93	.30	.23
2½	.70	.75	.24	.10
3	.46	.56	.09	.19
3½	.38	.61	.08	.11
4	.31	.27	.06	.06
4½	.40	.56	.00	.00
Avoids Risk				
2	.50	.62	.10	.15
2½	.62	.83	.21	.35
3	.64	.70	.12	.28
3½	.54	.67	.09	.20
4	.62	.64	.04	.13
4½	.27	.56	.00	.11
Bosses Others				
2	.20	.31	.00	.00
2½	.32	.46	.00	.05
3	.57	.52	.07	.10
3½	.55	.67	.15	.19
4	.65	.81	.23	.31
4½	.80	.78	.40	.44
Cries Easily				
2	.70	.93	.20	.15
2½	.71	.78	.18	.25
3	.56	.67	.12	.22
3½	.61	.72	.14	.11
4	.50	.46	.15	.08
4½	.53	.44	.00	.00
Criticizes Others				
2	.50	.38	.00	.08
2½	.50	.65	.03	.08
3	.60	.65	.07	.09
3½	.65	.77	.12	.21
4	.66	.81	.10	.27
4½	.73	.78	.13	.33
Fears High Places				
2	.22	.62	.00	.23
2½	.53	.65	.12	.18
3	.54	.60	.08	.18
3½	.40	.51	.06	.08
4	.31	.39	.00	.02
4½	.20	.55	.00	.11
Fears Strange People				
2	.33	.62	.00	.08
2½	.42	.50	.06	.06
3	.40	.54	.07	.11
3½	.36	.37	.01	.07
4	.21	.33	.04	.02
4½	.13	.33	.00	.00
Jealous				
2	.30	.15	.10	.00
2½	.18	.43	.00	.03
3	.23	.33	.05	.02
3½	.26	.49	.02	.04
4	.35	.35	.02	.04
4½	.40	.44	.07	.11

Behavior	To Any Degree Boys	To Any Degree Girls	Habitually Boys	Habitually Girls
Misrepresent Facts				
2	.00	.00	.00	.00
2½	.06	.23	.00	.00
3	.20	.25	.01	.02
3½	.23	.27	.00	.05
4	.23	.31	.00	.06
4½	.57	.22	.00	.11
Refuses Food				
2	.89	.62	.44	.23
2½	.53	.67	.09	.33
3	.63	.66	.16	.19
3½	.53	.69	.08	.23
4	.49	.65	.14	.10
4½	.57	.38	.29	.00
Shrinks from Notice				
2	.30	.23	.00	.00
2½	.32	.50	.06	.15
3	.42	.45	.04	.09
3½	.29	.28	.03	.10
4	.33	.35	.04	.10
4½	.27	.56	.00	.11
Seeks Praise				
2	.50	.38	.00	.08
2½	.50	.70	.06	.20
3	.70	.66	.08	.21
3½	.64	.73	.16	.27
4	.73	.89	.29	.32
4½	.73	.67	.07	.22
Stays near Adult				
2	.50	.93	.10	.23
2½	.44	.95	.18	.25
3	.45	.63	.03	.13
3½	.32	.66	.02	.18
4	.44	.58	.02	.06
4½	.33	.69	.00	.22
Sucks Thumb, day				
2	.25	.54	.00	.23
2½	.38	.55	.12	.13
3	.40	.42	.07	.12
3½	.27	.46	.07	.12
4	.29	.29	.06	.06
4½	.27	.44	.07	.00
Tells Fanciful Stories				
2	.00	.00	.00	.00
2½	.12	.33	.00	.03
3	.41	.38	.04	.03
3½	.30	.49	.07	.04
4	.52	.46	.10	.10
4½	.48	.33	.00	.11
Twists Hair				
2	.20	.64	.00	.23
2½	.26	.58	.00	.10
3	.50	.65	.04	.16
3½	.32	.54	.05	.05
4	.46	.58	.06	.12
4½	.33	.44	.00	.22

tion, especially since the two physical characteristics just described do represent two of the more clearly established differences between boys and girls.

It is not too improbable either to consider the possibility that the traditional roles in which men and women have been placed -- men as protectors, women as the weaker sex -- might have left an inherent mark on the present generation.

Since extroversion seems to decrease with age (41) it might also be that the earlier maturing of girls has something to do with the behavior differences noted in the sexes. This theory might explain the disappearance of sex differences at the college level, when boys and girls are more nearly equal in terms of general

maturity.

Regardless of what the factors are which tend to make for the greater extroversion of boys and introversion of girls, the search for them would seem to be our next most profitable line of attack.

Even though we may not agree completely that sex differences in behavior exist the evidence in favor of that view would make it seem worthwhile to adopt temporarily such a premise as a basis for future research.

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VARIATIONS IN THE INTELLIGENCE QUOTIENT OF 105 CHILDREN

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The problem of the constancy of the intelligence quotient is one which is raised again and again in psychological discussions and text-books. It is generally assumed, on the basis of the Binet test, that the I.Q. remains constant from year to year except for such slight changes as may be due to differences in the physical condition of the child, his interest, the personality of the tester and the practice effect which ensues in view of the fact that the child has been tested before. When such changes occur, they are seldom progressively upward or downward but rather of a haphazard nature. Previous studies have shown that the average change in I.Q. is about five points occurring in 15 per cent of cases. It has been demonstrated, further, that when a partial organic handicap has been removed the I.Q. may rise appreciably and remain at the new level.

In an effort to contribute to these findings it seemed to us to be of value to search the annual files of the Child Guidance Clinic at the University of Pennsylvania and to make a special study of the cases which have been retested.[2] The testing technique of the clinic has been standardized and, in the majority of cases, the same examiner retests the child so that chance errors of a subjective nature are reduced to a minimum. The clinic, because of its staff and accessibility, handles a large number of cases every year but, as one might expect, it is the exceptional child who is most frequently referred for re-examination so that we find a larger number of children with I.Q.'s above 110 and below 90 than would happen if the group were unselected.

In the years 1934 to 1936, 1,148 cases were brought to be tested at the clinic and 105 of these were retest cases. Of the 105 cases, 87 had been tested twice, 15 cases three times, 2 cases four times, and 1 case five times. The interval between testing varies widely, the shortest span being four months and the longest six years. In the case of the former the first test was not completed because of the child's fatigue; in the latter case, the child had been diagnosed as feeble-minded on his first visit to the clinic and brought back solely for the purpose of checking the original diagnosis. The youngest child studied was one year nine months old at the time of the first examination; the oldest was eighteen at the time of the second examination. The test generally used was the Stanford Revision of the Simon-Binet. Other tests used at the discretion of the examiner were: the Kuhlmann-Anderson, the Otis Self-Administering test of Intelligence, the Thurstone and the Minnesota Pre-school test. Only cases in which the same test was used in all examinations or in which the test score was convertible into I.Q. ratings were utilized for the purpose of comparison. The basis for the selection of cases was a plus or minus variation of more than five points in the I.Q. at the time of retesting. The corresponding case-histories were then studied and an attempt made to classify and perhaps interpret the reasons for the changes.

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[2] Acknowledgment is made to Doctor Miles Murphy, of the University of Pennsylvania Clinic, through whose courtesy the clinic files were made accessible.

In 30 cases the I.Q. was constant within 5 points
In 23 cases the I.Q. increased more than 5 points
In 36 cases the I.Q. decreased more than 5 points
In 7 cases no quantitative estimate is given for the first mental age
In 2 cases no quantitative estimate is given for the second mental age
In 7 cases the I.Q. fluctuated up and down

The 23 cases whose I.Q. increased more than five points may be listed as follows:

Case	Age			I.Q.			T.C.*		Factors
A	2-9		4-5	90.9		117	26.1		Excessive distractibility; age.
B	5-1	3-	6-7	88.5		96.2	7.7		Dysoracin; speech blockage.
C	3-4	3-11	5-1	85	106.3	111.4	21.3	5.1	Birth injury. Prognosis good. Intercranial hemorrhage; enlarged thymus, ataxic diplegia.
D	6-9		11-9	96		111.3	15.3		Disciplinary problem; schooling intervened.
E	4-5		7-3	85		103.4	18.4		Emotional block; schooling intervened.
F	5-3		9-5	119		139	20		Behavior problem due to home environment. More cooperative in 2nd examin.
G	4-2		5-6	96		112	16		Behavior problem. Spoiled and non-cooperative. Nursery school and kindergarten intervened.
H	5-3		9-10	71		101.6	30.6		Microcephalic. Schooling intervened.
I	7-8		8-8	73.9		82.7	8.6		Trauma as infant; severe childhood diseases. Unfavorable prognosis.
J	5-11		9-0	114		144.4	30.4		Speech mutilation.
K	4-3		7-1	80.2		100.2	20.0		Speech difficulty.
L	4-1		9-7	159		165.2	6.2		Superior child. Clinic teaching.
M	7-0		11-10	71		88	17		Speech mutilation.
N	6-6		8-11	141		159.8	18.8		Superior child. Interested in music.
P	6-1		9-10	98.6		110	11.4		Behavior problem due to lack of discipline. Schooling intervened.
Q	8-1		9-3	119.7		128	8.3		Glasses.
R	1-9		3-10	115		134.7	19.7		Age factor.
S	9-10		10-0	83.9		93.3	9.4		Myxedema. Fear psychosis. Clinic teaching intervened. Less tension at second test.
T	4-9	5-9	8-9	73	95	109.5	22	14.5	(Possibly syphilitic; lack of coordination and concentration) Helped by mother. Clinic teaching.
U	6-10		13-11	120		131.1	11.1		Unusual change upward. Nervous at time of first examination. Physically better.
V	8-11		14-7	93		105	12		Clinic teaching. Otis second time.

* T.C. - Total Change

Case	Age			I.Q.				T.C.*	Factors
W	5-5		9-1	136.4		142.2		5.8	Familiarity with test (Examiner favorable).
X	3-2	3-10	4-11	126	143.4	152.3	17.4	0.9	Unusual educational opportunities.

*T.C. - Total Change

Of the 23 cases whose I.Q. increased more than five points, the smallest increase was 5.1 and the largest increase was 30.6. The lowest I.Q. on the first testing was 71, the highest 159; the lowest I.Q. on the retest was 88, the highest 165.2. The distribution of the I.Q.'s on the first testing is as follows:

150-160	1
140-150	1
130-140	1
120-130	2
110-120	4
100-110	0
90-100	5
80- 90	5
70- 80	4

The ages of the children tested tend on the average to be at the lower testing levels at the first test which corroborates the conviction that the tests of young children are not as valid as those of older children. The average age of the 23 children was between 5 and 6 years.

Analysing our case records show that improvement in physical conditions would account for the rise in I.Q. in cases C, I, S, T and U. In most of these cases a favorable prognosis was given at the time of the first examination; in one case, I, the prognosis was unfavorable. The overcoming of speech difficulties was a significant fact in cases B, J, K and M. Behavior problems, with schooling intervening between the first and second tests, influenced the I.Q. in cases D, E, F, G and P. In case Q the correction of an eye defect may account for the 8.3 increase in quotient. In cases A and R the age factor accounts adequately for the improvement in the second test. Four cases, L, N, X and W are cases of superior children in whom the rise in I.Q. seems to indicate a real advancement, but even here such advantages as clinic teaching (L), or unusual educational opportunities (X) must be taken into consideration. In case V either the clinic teaching or the change in test might determine the rise. Case H with his 30.6 rise in I.Q. and case W, because of the data on his siblings, deserve special mention.

"H" is a Jewish boy, five years three months old, whose mother brought him to the clinic because she found it impossible to discipline him or keep him clean. On the Binet he made an I.Q. of 71. He was described by the examiner as being infantile in appearance and behavior and having the characteristics of an "amiable imbecile." His head girth, 48 centimeters, suggested microcephalic imbecility. It was considered at the time of the first examination that the I.Q. was a fair estimate of his intellectual capacity and that he was possessed of "innate deficiencies exaggerated by exceedingly poor home training." The mother of the child is described by the examiner as being herself an inadequate, inefficient person. The second examination of H, done when he was nine years ten months old, shows considerable improvement. His I.Q. had jumped to 101.6, his school report (4 B

grade) showed his work to be fair and his conduct good. It might seem that this case is clearly one of misinterpretation of ability added to better discipline, but it is complicated by the picture of his brother whose I.Q. decreased 18.5 points and who will be discussed later in this paper.

"W" is one of five children, all of whom had been studied at the Pennsylvania clinic. A comparative profile made in 1934 of the siblings is of interest.

	William	Robert	Peter	Ethel	Stephen	Virginia
Age-Birth date	17 yrs. July, '17	14 yrs. Nov., '19	12 yrs. Oct., '21	10 yrs. June '24	9 Yrs. Oct., '25	4 yrs. April, '29
Grade in school	College freshman	10th	8th	5th	4th	Not in school
Psychological Data						
B.S. I.Q.		(Otis) 102	124.6	98.5	142.2	123.6
Personality	Serious. Dominant. Self-sufficient	Conscientious. Sensitive. Holds to own opinion	Self-confident. Precise	Quiet	Spoiled. Cooperative. Agreeable	Sweet. Shy. Cooperative
Interest	Printing. Passing interest in law	Mechanically minded. Interest in music. Sings	General interest in school work	Interest in writing especially poetry	A bit young	None yet
Diagnosis	Normal mentality. Superior to 80% of boys of his age	Normal mentality. Limited ability. Inferior to others	Normal mentality. Superior to 80% of boys of his age	Normal mentality. In median group	Superior to 90%	Superior to 80%

The 36 cases whose I.Q. decreased more than five points may be listed:

Case	Age			I.Q.			T.D.*		Factors
1	8-9	10-3	13.5	81.9	75.6	52.1	6.1	23.5	Polyglandular dysfunction.
2	12-3	14-3		120	111		9		Numerical decrease at 13-14 yr. level of S.-B.
3	8-9	10-11		135	129		6		Otis given second time
4	9-11	14-2		169	133		36		Socially distraught. Otis given second time. Age level.
5	4-7	9-2		142	134.5		7.5		Psychologist's estimate is that the child has improved.
6	8-3	12-8		137	130.2		6.8		Numerical decrease in upper level of S.-B.
7	10-1	10-5	14-7	119	116	105	3	11	*Constitutional difficulty.* Lack of motivation.
8	4-9	5-9		89.4	72.4		17		Maternal thyroidectomy. Child had rickets and feeding difficulty.
9	7-11	9-11		50.5	40.7		9.8		Feeble-minded child. Meningitis at 15 mos.
10	4-8	8-6		128	107.6		20.4		Possible lack of persistence.

* T.D. - Total Decrease

Of the 36 children whose I.Q. decreased more than five points the smallest decrease was six and the largest was 36. The lowest I.Q. on the first testing was 50.5, the highest 160; the lowest I.Q. on the re-examination was 40.7, the highest 141.4. The distribution of I.Q.'s on the first examination was as follows:

160-170	2
150-160	2
140-150	2
130-140	6
120-130	7
110-120	2
100-110	1
90-100	4
80- 90	6
70- 80	0
60- 70	1
50- 60	3

The ages of these children tend on the average to be higher than those of the increasing group and point in some cases to an acknowledged defect in the first Stanford Revision of the Binet tests at the higher levels. The average age of the 36 children is between six and seven.

Serious physical difficulties, which have not improved, explain the lower I.Q. in Cases 1, 8, 9, 13, 16, 17, 22, 28, 29, and 32, and in three cases (9, 13, and 16) the children fell into the feebleminded category at the time of the first examination. In the latter cases, moreover, the decrease in I.Q. (9.8, 6.0, and 8.5) is relatively small. Speech defect is mentioned in the psychologist's record as being probably accountable for the lowered quotients of Cases 20 and 34, and Case 34 is also microcephalic and a behavior problem. Test defect, that is, the numerical decrease at the 12-14 level in the first Stanford Revision of the Binet, is offered as a causal factor in Cases 2, 4, 6, 14, 19, and 36. A psychological etiology is considered important in the diminished I.Q. of Cases 7, 10, 11, 12, 21, 23, 25, 30, and 35.

In case 21 the examiner predicted a lowering of the I.Q. because of the child's low emotional age and in Cases 23 and 30 the examiner himself was dissatisfied with the results of the second examination. In Case 31 the family history is bad, and in Case 18 there are a combination of circumstances, physical injury, illegitimacy and residence in a colored neighborhood, tending to handicap the child. In Cases 3 and 27 the Otis was given the second time and the variation in I.Q. is almost within the normal range.

Case 25 has a history of nervousness and inability to sleep at night after awakening one night and seeing a burglar in his room. In Case 5 the psychologist feels that the child has improved in spite of the decrease in I.Q. This child is the only one of the whole retested group who is listed as having eidetic imagery. In Cases 15, 26, 33, and 37 the examiner considers the tests at the lower level to be too easy and in Case 26 he predicted a future decrease in these emphatic terms: "the relative superiority of this child will diminish with age."

Case 3, which showed the greatest change in I.Q. in the decreasing group, is that of a Jewish girl who has special ability in language and writes fairly good poetry but is extremely neurotic and introverted and seems unable to make a

satisfactory social adjustment. Cases 35 and 36 are siblings to Case W and are included in the profile studies given previously.

Eight cases had I.Q.'s which moved up one time and down the next or vice versa.

Case	Age	I.Q.	T.C.*	Factors
a	4-6, 6-4, 9-5	100, 95, 105.3	-5, +10.3	Poor cooperation and emotional instability in earlier tests.
b	5-9, 7-0, 8-12 10-12, 13-4	116, 110.7, 113.2 113.1, 118.7	-5.3, +3.5 -.1, +5.6	Normal range of elevation.
c	4-10, 5-9, 6-9	138, 145, 138	-7, +7	Myxedema and eye corrective trouble treatment.
d	7-4, 9-3, 14-2	114, 106.3, 108.8	-7.7, +2.5	Lacks intellectual motivation.
e	4-7, 9-4, 13-11	92, 105.3, 86.8	+13.3, -10.8	Moral imbecile, lack of consistent discipline.
f	9-7, 9-8, 9-10 13-7	57.4, 54.3, 66, 52.7	-3.1, +11.7, -15.3	Feeble-minded Emotional instability.
g	9-11, 12-11, 13-7	88, 90.3, 79.7	+2.3, -8.3	Mental deterioration with oncoming adolescence.

*T.C. - Total Change

The above group of cases are not particularly striking, but one case "e" deserves mention. He is the sibling of the microcephalic child "H" whose I.Q. increased in successive testings.

It would seem after a careful examination of all the cases listed that increase, decrease and fluctuation in I.Q. is dependent on a combination of causes and not on any one dominant factor. Physical and psychological abnormalities play an important role in changing intelligence quotients, while age and test defects run a close second.

MINOR STUDIES ON SIGHTING PREFERENCES

BLAKE CRIDER [1]

The purpose of this study was to see to what extent a number of conditions were related to the eye preferred for unilateral sighting, commonly called eye dominance. The conditions studied were: 1) Distance of the eye from the point sighted; 2) the effect of the hand used in holding the sighting object; 3) visual acuity and eye closure facility; 4) sex, and 5) intelligence.

The subjects used were children ranging from six to twelve years of age. The tests were commonly used tests of eye dominance which required the child to sight at an object, such as pointing, looking through a ring, aiming, looking through a conical tube and so on.

I. A common procedure in testing for the dominant eye is to have the subject point at the examiner's nose. It was noticed that the distance the examiner stood from the child differed from examiner to examiner and from time to time by the same examiner. Does this variation make any difference?

Three different tests were used. Each test was repeated twice: once with the test object three feet away and once twenty feet away. The first test required the child to look through a hole punched in a square of cardboard. Only six children out of 222 changed eye on change of the distance of the fixation point. Permitting the same children to sight through a ring fixed at the end of a holder resulted in only five changes of eye preference with change of distance. Distance of the fixating object therefore does not seem important.

II. William James said that with the left hand we point over the left eye and with the right hand we point over the right eye. (1) Was James right? In the test requiring the subject to sight at an object through a ring we used 717 children, each child sighting once with the right hand holding the ring and once with the left hand holding it. Only fifteen subjects out of the 717 sighted with the left eye with the left hand and the right eye with the right hand. The hand used in the sighting operation does not seem to be important in determining eye preference.

III. The editor of the American edition of Helmholtz's Treatise on Physiological Optics holds that "Nearly everybody has a dominant eye which governs the other eye and in which the vision is superior to that in the other eye." (2). We have not found that statement true.

In a group of 657 subjects we found 66 who had a difference in the acuity of the two eyes yet neither eye had better than 10/10 vision as determined by the Snellen chart. Each of the 66 subjects was given an opportunity to sight 13 times and those sighting all 13 times were considered to have a definite eye preference if they used the same eye each time. If we take the group thus being classified as having a dominant eye we find 28 subjects, one-half of whom had the right eye weaker than the left eye and one-half had the left weaker than the right. We have 14 subjects with a definite left eye preference. Eight had the right eye weaker and six had the left eye weaker.

[1] From Cleveland, Ohio.

CHILD DEVELOPMENT, Vol. 8, No. 4 (December, 1937)

Visual acuity as herein measured does not seem to be related to the dominant eye. Actually our data show that children having 1/10 vision in one eye and 6/10 in the other will sight with the weaker eye. This does not necessarily mean that a visual defect does not influence the sighting eye. Our data merely indicate that by knowing the eye with the greater visual efficiency we are unable to predict which will be the sighting eye.

In our practical problems of sighting, such as aiming a gun or looking through a telescope, the usual procedure is to close one eye and aim with the other. Most people report that one eye is more readily closed than is the other. Those who do not report this experience nevertheless show by their facial muscles that one eye is much more easily closed than is another. We found 57 children who had a difference in the visual acuity of their eyes and who showed that one eye was more easily closed than the other. Thirty-one of these children saw better with the right eye but 67.74 per cent closed the left eye. In the case of the 26 subjects with the more efficient left eye only 38.46 per cent closed the right eye. Eye closure preferences therefore are not highly related to visual acuity differences.

IV. In our study we had 250 boys and 386 girls who had made at least 13 sightings on the various tests. We arbitrarily considered definite eye preference occurring where the child sighted all 13 times with the same eye. Any variation from this consistency was considered impartial eyedness. The results appear in Table 1.

TABLE 1

Percentage of Eye Preference According to Sex

Sex	R.E.	P.E.	L.E.	P.E.	I.E.	P.E.
Boys	50.77%	1.71	21.50%	1.41	27.73%	1.54
Girls	44.57	1.79	22.28	1.50	33.15	1.70
Diff.	6.20		.78		5.42	
P.E.d.	2.47		2.06		2.29	
D/P.E.d	2.51		.38		2.37	

There is no indication from these data that eye preference is related to sex differences.

V. Intelligence quotients were available for 517 children who also had made thirteen sightings. Approximately fifty per cent of these quotients were obtained from the Stanford Binet and the others were from commonly used group tests. The mean intelligence quotient was computed for three eyedness groups and the results appear in Table 2.

TABLE 2

The Mean Intelligence Quotient for Three Eyedness Groups

Eyedness	Mean	S.D.	P.E.m	N
Right	113.16	14.39	.59	275
Left	112.46	13.60	.71	127
Impartial	115.63	14.49	.91	115

These data indicate there are no significant differences in the intelligence of groups divided according to eye preference.

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(2) Helmholtz, H. L. F. v. Treatise on physiological optics. New York, Optical Society of America, 1935, Vol. III, pp. 7.

A COMPARATIVE STUDY OF MOTOR ABILITIES OF NEGROES AND WHITES

ADELE RHODES[1]

This study had a three-fold purpose: (1) to establish tentative norms of motor abilities of negro children; (2) to compare the motor abilities of negro children with those of white children; (3) to compare the motor abilities of both groups of children with groups of adults of both races.

There is little material dealing with the motor abilities of children. The study most directly related to the present one is by Goodenough and Smart (1). From results of a series of tests given to 154 children from 2½ to 5½ years of age, these investigators concluded that scores improve with age, sex differences are very small, reliability coefficients are high and intercorrelations between the tests are low. The first group factor present in all the results was tentatively described as general motor maturity, a second group factor appeared to be related to carefulness or attentiveness. Other investigators dealing with different phases of motor ability have agreed in finding a marked increase of motor control with age, but findings in regard to sex differences vary with the test used.

In the psychological studies of race, more attention has been paid to intelligence than to anything else. Klineberg (2), however, studied negroes and whites on performance tests, concluding that these tests measured mainly speed differences, which in turn were conditioned by environmental factors. Peterson and Lanier (4) gave speed tests of varying complexity to white and negro college students. They concluded that the degree of white superiority varies directly with the complexity of the performance. Lambeth and Lanier (3), testing thirty 12-year-old boys of each race, stated that since the whites do not excel in all types of processes, it is misleading to speak of "speed" differences in general. The main conclusion of the few experiments in which racial differences in motor abilities have been studied is that the negroes seem to be equal or superior to the whites. However, the number of such studies has been small and, as far as the writer is aware, none has dealt with young children on whom the influence of the social milieu has had a shorter time to operate.

The subjects for the present investigation were 80 negro children, 20 in each age group between two and five years old; also two groups of adults, 24 negroes and 20 whites, all university students. For purposes of comparing the negro children's scores with those of white children of the same ages, the figures obtained by Goodenough and Smart (1) were used.

The negro children were given four of the motor ability tests used on the study just cited: the "walking path," the needle-threading test, the three-hole test, and the stylus tapping test. For more detailed descriptions of these tests and of the procedure used in administering them, the reader should refer to the article by Goodenough and Smart. All the children were tested in the gymnasium of the Phyllis Wheatley Settlement House in Minneapolis. Two trials were given on each test. The total time required for testing each child was about 15 minutes.

[1] From the Institute of Child Welfare, University of Minnesota.

CHILD DEVELOPMENT, Vol. 8, No. 4 (December, 1937)

Table 1 shows the mean scores and their standard deviations on the separate tests for each of the four age groups, sexes being combined. As was to be expected, the scores improve steadily with age, except in two instances: the time required for walking the path by the 2½ year-olds and the number of stylus taps made by the 5½ year-olds. The 2½ year-olds walked fast, but seemed not to be aware of the errors they were making. A similar tendency was noted by Goodenough and Smart.

TABLE 1

Means and Standard Deviations from the Means on Five Motor Ability Tests for White and Negro Children in Four Age Groups, and for White and Negro Adults

Age and Race	Number of Cases	Walking Path: Time		Walking Path: Errors		Needle Threading		3-Hole Test		Stylus Tapping	
		M	SD	M	SD	M	SD	M	SD	M	SD
Negro children											
2½	20	20.4	3.5	19.6	1.9	103.5	40.2	Not given		102.8	13.1
3½	20	28.9	9.5	14.0	6.7	56.3	17.1	32.7	7.5	133.0	12.6
4½	20	21.5	4.3	6.0	3.3	34.2	15.3	37.5	11.6	156.2	18.6
5½	20	19.5	4.6	3.1	1.2	24.6	8.1	51.1	12.5	151.6	18.5
White children											
2½	20	22.7	5.4	23.7	10.6	122.4	113.2	Not given		103.5	26.4
3½	24	31.5	18.8	13.1	8.5	59.2	50.9	36.7	9.9	136.1	19.2
4½	30	24.1	11.8	6.0	4.7	50.5	28.4	46.2	10.6	154.0	36.3
5½	80	21.7	9.4	3.1	2.3	32.8	17.4	56.2	11.1	151.5	27.3
Negro adults	24	13.2	3.1	1.5	1.1	10.5	4.3	80.8	17.5	345.8	44.6
White adults	20	14.7	1.9	1.9	1.4	10.5	2.8	88.7	9.6	346.4	56.4

Correlations between the first and second trials of the various tests range from .70 to .95 for single-year age groups. Of the 19 coefficients, all except 4 are above .85. Most of the intercorrelations between the various tests at successive ages are low, the highest being +.55.

Thurstone's method of factor analysis was applied to the results in order to see how the loadings would compare with those obtained for white children. (See Tables 2-3).

TABLE 2

Factor Loadings for the Several Tests

Factor I

	Age: 3½	4½	5½	Adults
Negro				
Speed, walking path	-.315	+.119	-.068	+.637
Fewness of errors, walking path	+.358	+.305	+.289	+.609
Speed, needle threading	+.824	+.450	+.283	+.544
Three-hole test	+.360	+.842	+.669	+.506
Stylus tapping, speed	+.650	+.332	+.335	+.746
White				
Speed, walking path	-.304	+.105	-.088	+.734
Fewness of errors, walking path	-.104	+.422	+.385	+.585
Speed, needle threading	+.611	+.372	+.498	+.672
Three-hole test	+.359	+.028	+.711	+.639
Stylus tapping, speed	+.546	+.340	+.330	+.731

TABLE 3

Factor Loadings for the Several Tests

Factor II

	Age			
	3½	4½	5½	Adults
Negro				
Speed, walking path	-.263	-.338	-.110	+.211
Fewness of errors, walking path	+.251	+.309	-.268	+.033
Speed, needle threading	-.069	+.178	+.115	+.076
Three-hole test	+.687	+.131	+.275	-.019
Stylus tapping	-.615	-.118	-.326	-.161
White				
Speed, walking path	-.278	-.087	-.217	+.012
Fewness of errors, walking path	-.314	+.763	-.200	+.114
Speed, needle threading	-.031	+.269	+.308	+.024
Three-hole test	+.796	+.162	+.223	+.100
Stylus tapping	-.300	-.330	-.263	+.012

As in the earlier study at least two group factors appeared to be present. Inspection of the loadings for the different tests lends support to the suggestion offered by Goodenough and Smart, that the first factor may best be called general motor maturity, while the second represents something akin to carefulness or attention.

Examination of the three tables leads to the conclusion that as far as motor abilities of the kind measured by these tests are concerned, there is little, if any, difference between negroes and whites at any level of development. Considering the small number of cases studied, both the rate of motor development and the organization of motor abilities as brought out by a factor analysis are strikingly similar for the two races.

REFERENCES

(1) Goodenough, F. L. and R. C. Smart: Interrelations of motor abilities in young children. *Child Development*, 1935, 6, 141-153.

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(3) Lambeth, M. and L. H. Lanier: Race differences in speed of reaction. J. Gen. Psychol., 1933, 42, 255-297.

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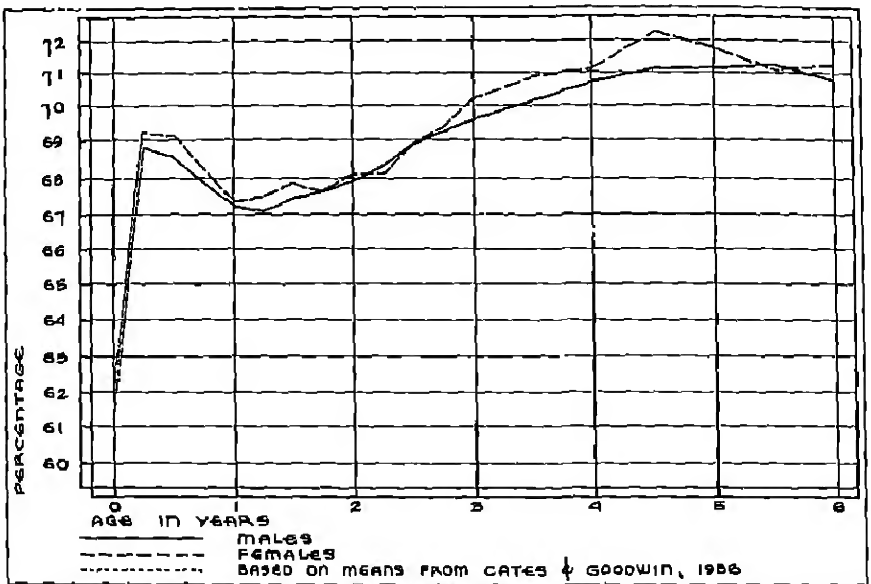

Figure 3. - Hip/Shoulder Index: Curves for Males and Females Drawn to the Series of Mean Values Given in Table 3 and to Supplementary Data from Cates and Goodwin (4).

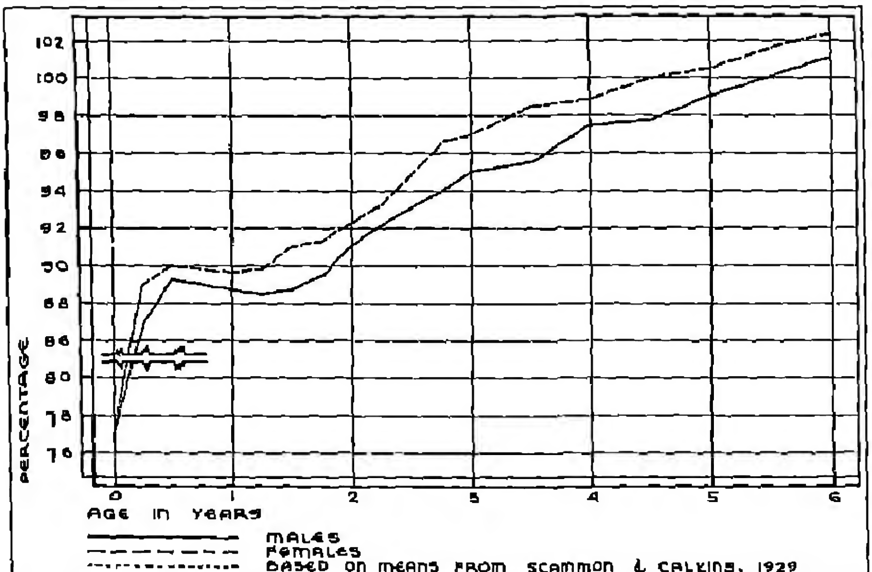

Figure 4. - Hip/Chest Index: Curves for Males and Females Drawn to the Series of Mean Values Given in Table 4 and to Supplementary Data from Scammon and Calkins (9).

females. The index values were distributed and analyzed in a manner similar to that employed for the hip/shoulder index. Table 4 gives the numerical results, while graphic portrayal of the age progression in means for each sex is made in Figure 4.

Since data for transverse diameter of the thorax were not secured on the group of newborn infants, an estimate of the hip/chest index at the end of the fetal period was obtained from mean dimensional values given by Scammon and Calkins (9). These authors present means for full-term fetuses of 7.9 cms. for bi-iliac diameter of the hips and of 10.3 cms. for transverse diameter of the thorax at the xiphoid level. The ratio of the former to the latter indicates that the hip/chest index lies in the vicinity of 77 at the close of prenatal life.

It is found that:

1. A decided modification in trunk proportion, as evidenced by the hip/chest index, occurs between the close of prenatal life and the sixth postnatal year. Whereas bi-iliac diameter of the hips is estimated to approximate 77 per cent of the chest width at ten fetal months, by six years of age the hip width exceeds the chest width.

2. During the first six months of postnatal life there is a rapid acceleration

TABLE 4

Bi-iliac Diameter of Hips in Percentage of Transverse Diameter of Thorax at Xiphoid Level*

Mean Age		Cases	Mean	Standard Error of Mean	Standard Deviation	Range
Year	Month					
			Males			
	3	65	87.2	.60	4.82	79.7 to 104.4
	6	109	89.3	.87	5.99	76.8 to 107.9
	9	136	89.1	.46	5.34	77.0 to 103.1
1	0	152	88.8	.45	5.60	75.6 to 103.2
1	3	141	88.5	.40	4.73	76.6 to 100.8
1	6	116	88.7	.42	4.54	77.0 to 99.4
1	9	103	89.6	.45	4.57	78.4 to 100.6
2	0	109	91.2	.45	4.74	82.0 to 102.4
2	3	101	92.1	.43	4.31	79.8 to 100.6
2	6	94	93.1	.44	4.23	84.9 to 103.9
2	9	97	94.0	.52	5.07	83.7 to 109.3
3	0	113	95.0	.46	4.92	83.9 to 109.2
3	6	106	95.8	.44	4.52	83.1 to 107.8
4	0	102	96.7	.52	5.23	82.3 to 111.0
4	6	100	97.8	.49	4.92	84.5 to 111.4
5	0	103	99.1	.49	5.02	86.3 to 111.8
5	6	110	99.9	.59	6.18	84.8 to 119.4
6	0	101	101.2	.65	6.60	86.7 to 120.6
			Females			
	3	61	88.9	.70	5.56	76.7 to 98.6
	6	108	90.4	.58	5.99	75.6 to 107.5
	9	117	89.9	.51	5.50	75.3 to 105.4
1	0	119	89.6	.52	5.63	74.7 to 103.0
1	3	108	89.8	.45	4.65	78.3 to 99.4
1	6	97	91.2	.44	4.34	77.7 to 100.7
1	9	87	91.4	.54	5.05	78.4 to 103.8
2	0	74	92.3	.58	5.03	80.6 to 105.3
2	3	76	93.3	.58	5.05	83.4 to 107.3
2	6	68	95.0	.57	4.67	84.4 to 105.5
2	9	66	96.5	.60	4.80	86.2 to 106.7
3	0	66	96.9	.57	4.62	86.1 to 109.5
3	6	75	98.4	.57	4.95	87.8 to 111.3
4	0	76	98.8	.52	4.63	87.5 to 110.0
4	6	83	99.6	.49	4.47	91.4 to 109.3
5	0	93	100.6	.50	4.86	90.3 to 111.0
5	6	91	101.3	.53	5.05	90.7 to 115.3
6	0	88	102.3	.55	5.16	92.4 to 110.1

*The basic data are measurement values for Iowa City males and females of northwest European descent.